29 July 1947 *Price* 10*s*. 0*d*.

PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

158th Session (1945-46)

Vol. 158 Part 2

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Editorial Note.—To facilitate citation, it has been decided to give the ' Proceedings ' Volume-numbers, beginning with Vol. 158, which has been chosen as the arbitrary number and which agrees with the number of the Session.

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PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON
Session 1945–46

Vol. 158 Part 2

PROCEEDINGS OF THE GENERAL MEETING ON 21 March 1946

Colonel F. C. Stern, O.B.E., M.C., Vice-President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 7 March 1946, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Dr. Agnes Arber, Dr. W. E. Collinge, Capt. Eric Hardy, Dr. Annie Porter, Dr. G. S. Puri, Mrs. E. Warren, the Royal University, Uppsala and the Cooper Technical Bureau.

The following Fellow signed the Obligation in the Roll and Charter Book, and was admitted a Fellow :—Mr. Edgar Pickard.

The following were elected Associates :—Miss Erica Millicent Moore, B.Sc., and Gordon Edgar Barnes, M.A.

The Vice-President in the Chair, reported the deaths of Mr. Hayward Radcliffe Darlington and the Rev. Canon Francis William Galpin, Fellows of the Society.

The following communications were read and discussed after the Vice-President, in the Chair, had read a cable from India sent by Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., expressing his best wishes for the success of the present meeting ; and had welcomed the presence at the Meeting of Dr. Johan Hjort, F.M.R.S. (Norway), Dr. H. Blegvad (Denmark), and Dr. K. A. Andersson (Sweden).

Discussion on Oceanography.

Introduction. By Henry G. Maurice, C.B.

The Physico-chemical aspect. By Dr. G. E. R. Deacon, F.R.S.

The Fertility of the Ocean. By Dr. H. W. Harvey, F.R.S.

Marine Zoology. By F. S. Russell, D.F.C., D.S.C., F.R.S.

Oceanography and Fisheries. By Lieut.-Commander J. R. Lumby.

(Discussed by Vice-Admiral Sir John Edgell, K.B.E., C.B., F.R.S., Dr. J. N. Carruthers, Dr. Johan Hjort, Dr. H. Blegvad ; Mr. Henry G. Maurice made some concluding remarks.)

[This Discussion is printed in full, below.]

DISCUSSION ON OCEANOGRAPHY.

THE following communications were read and discussed after the Vice-President in the Chair had read a cable from India sent by Lt.-Col. R. B. SEYMOUR SEWELL, C.I.E., F.R.S., expressing his best wishes for the success of the meeting ; and had welcomed the presence at the Meeting of Dr. Johan Hjort, F.M.R.S. (Norway), Dr. H. Blegvad (Denmark), and Dr. K. A. Andersson (Sweden).

Mr. HENRY G. MAURICE, C.B., President, Zoological Society of London,—

This meeting of the Linnean Society is to be a symposium of oceanography. It is my privilege to introduce to you four men of science, all of whom are members of the Challenger Society, who need no introduction in an assembly of oceanographers (for they are all recognized masters of their subject), but who may perhaps be unfamiliar to a few of those present at this meeting.

First is Dr. G. E. R. Deacon, F.R.S. and a member of the Research Staff of the Admiralty, who will discuss the Physico-Chemical Aspect of Oceanography, with particular reference to the development of the physico-chemical study of the sea in the last half century, and the need and the opportunity for a great advance in this field of research.

Next is Dr. H. W. Harvey, F.R.S., of the Marine Biological Association of the United Kingdom, based on Plymouth. He will discuss the fertility of the Ocean, which is intimately bound up with the chemical processes taking place at different seasons and in different parts of the Ocean.

Following him, Mr. F. S. Russell, F.R.S., Director and Secretary of the Marine Biological Association, who, let me add, has but recently renewed his association with oceanography, after winning distinction in the air during the war, will speak about Marine Zoology.

Finally, Commander Lumby of the Scientific Staff of the Fisheries Department of the Ministry of Agriculture and Fisheries will deal with some aspects of the application of the findings of physico-chemical investigations to the solution of biological problems.

These four speakers have been placed, I think, in the correct logical order of the subjects they will bring before you. We start with the oceans and seas, their composition, their temperatures, their drifts, currents, waves, superficial and submarine, and all those movements which may be summed up in the words ' water circulation ', a fascinating subject of great complexity.

These topics properly and, indeed, inevitably, come first because they are of the very essence of our subject—first the sea, *then* all that is therein. Obviously, you can no more study life in the sea without understanding its environment than you can life on the land and in the atmosphere which envelops this planet.

And so we pass to the fertility of the Ocean which is closely related to the chemical composition of the water. This chemical composition is by no means uniform. Different water masses, of varying chemical combinations, may have correspondingly different actual and potential degrees of fertility. Just as different soils, altitudes, climates and so on govern the variation of terrestrial life, so the varying composition, movements and interactions of the oceans largely govern the development of the plant growth, the phytoplankton, upon which, in its turn, animal life and growth depend.

At this stage the marine zoologist takes up the tale. I believe it is now accepted among biologists as a probability, amounting almost to certainty, that life as we know it, both marine and terrestrial, had its beginnings in the waters which cover approximately three-quarters of the earth's surface. It is not for me to attempt to trace the early stages of this development. I will content myself with reminding you that, according to the first chapter of Genesis, attributed to Moses, it was in the waters that the moving creatures that have life first appeared. Modern science has, I believe, endorsed that statement. The moving creatures that now have life in the oceans are multitudinous, absolutely, generically and specifically. And we need the fullest possible information about them and about all marine biology, because only in the light of such knowledge can we hope to achieve rational, controlled exploitation of the Fisheries which play so important a part in the welfare of a nation whose life-line is the sea. Just as the study of the sea's constituents and movements is essential to the study of marine biology, so is the study of marine biology as a composite whole to the specialized economic investigations which bear upon the future of the fishing and whaling industries.

I have always maintained, and I think few who have considered the question will dispute, that the primary importance to us of our Fisheries and of the Whaling Industry lies not in the food they produce but in the men and the ships which they maintain. They depend upon ships, mainly small craft, which in times of danger, as two wars have witnessed, can be diverted to essential service as part of the naval defence. And they produce first-class seamen. And, even in these days of mechanized ships and mechanized war, a trained seaman is more useful at sea than a landsman, especially when the handling of small craft is called for.

To these men the study of the sea has a two-fold importance, first for the purpose of navigation, secondly for the light that it throws upon the life of the creatures which are the material of their industry. And so, appropriately enough, Commander Lumby brings us back to the point from which we started and shows us, by examples, how the findings of physico-chemical research have been and will be applied to the biological problems germane to the rational exploitation of the Fisheries.

So you see that not only are all the branches of the whole study of oceanography, physical, chemical and biological interdependent, but, in combination, they minister to the safety and welfare of the nation.

In the subjects chosen for discussion this evening, while pride of place is given to the physico-chemical aspect of oceanography, the emphasis on the whole is laid on the biological. This is as it should be in an oceanographical symposium under the ægis of the Linnean Society, to whom we are grateful for the opportunity they have given to the oceanographers to discuss some of their many problems. But I hope I have made it clear that those of us who are primarily interested in the biological aspects of the subject recognize the fundamental part played in their study by physico-chemical studies of the Ocean, are grateful to the physical and chemical oceanographers for the help they give us, and desire that their side of oceanography should be developed to the uttermost. In fact, we supply them with extra ammunition for the fight for an Oceanographical Institute, and all that that implies.

I emphasise this point because Colonel Seymour Sewell, who instigated this meeting, and whose enforced absence we all regret, and others, including myself, have been at pains in recent discussions to press the claims of marine biology as an essential part of the whole study of oceanography. We do not wish to be misunderstood. We know that we cannot have too much physical and chemical oceanography, but, equally, we claim that marine biology must be taken into account whenever oceanography is under discussion.

We live by the sea, we depend upon sea-power for our very life. The development of air-power has not altered that fact. It has merely made more essential than before the study of the sea in those aspects which bear upon meteorology. Because we depend upon the sea we must know, as far as is humanly possible, all about it, not only a part. We need ships, and we need all possible information that will aid their navigation. We need also that which will enable us to maintain in prosperity those industries which, involving the use of ships, contribute to our food supplies in peace and to our naval strength in war.

Physical and Chemical Problems in Oceanography.

By G. E. R. Deacon.

In this country the study of the physical and chemical aspects of oceanography has received its impetus mainly from the study of marine biology and fishery research, its problems being recognized as fundamental to those of the plant and animal life. This close interdependence has led to the discovery of many relationships, and has greatly increased our knowledge of the physics and chemistry of the sea, but as the subject unfolds, and detailed observations introduce more precise problems, greater opportunities are needed for research of more individual character.

Our work has been largely descriptive, but in other countries, notably Scandinavia, where greater emphasis has been placed on the study of the physical aspect, they have been more energetic in applying analytical methods and the results of theoretical studies. They were more energetic in following up the early discoveries made during the voyage of H.M.S. *Challenger*, and the development of physical and chemical oceanography dates principally from their fundamental advances made at the beginning of this century.

Increased attention seems to have been paid to the subject after 1918. Large-scale expeditions were sent to all parts of the world, several of them devoted primarily to physical work, and others with this aspect well represented. It was a period in which the methods developed in the seas of north-western Europe were extended and improved, and applied in many parts of the world. Most striking of all was the rapid growth of physical and chemical oceanography in the United States, Japan and Russia.

One of the greatest advances was the development of echo-sounding methods, which are responsible for a wealth of new information about the sea-bottom, and the revelation that in some areas it is as rugged as any mountain landscape. The method was not welcomed by every one, because it discouraged the collection of bottom samples, but it can now be judged to have stimulated research. It has no doubt encouraged the study of sedimentation as well as the topographical aspect, and led to the development of more ambitious methods of studying the stratification of sediments.

The study of the water circulation in the oceans has been advanced mainly by charting the internal distribution of temperature and salinity, and drawing conclusions from gradual changes in the characteristic properties of a well-defined water mass as it moves away from its original position and mixes with other types. Some of the most striking movements are those in intermediate and bottom layers from the Antarctic zone well into the northern hemisphere. Also the deep southward movement from the North Atlantic Ocean to the Antarctic and round the Southern Ocean into the Pacific Ocean, and the highly saline undercurrent from the Mediterranean Sea which can be traced far south in the Atlantic Ocean.

Our knowledge, however, is largely qualitative. When such a question arises as: How long will it take the deep current in the Antarctic zone to carry adult *Euphausia superba* from the neighbourhood of the Antarctic convergence to their breeding grounds near the Antarctic continent ?, no reliable estimate can be made ; nor, for example, can we make an accurate assessment of the movements of a diatom which is circulating up and down in turbulent water.

Notable advances have been made in the study of tides. On the practical side much more is known of the relations between tides and tidal streams, and on the theoretical side some progress has been made in studies of the oceans. The nature of the problem is indicated by Professor Proudman's answer to the question : Why are the tides of the Mediterranean so small ? ; the answer being that ' the tides of the Mediterranean are just about the magnitude that the simplest dynamical theory indicates. The much more interesting question is : Why are the tides of the Atlantic so large ? '

In the study of waves, new advances have been made by the development of new methods of wave recording and analysis, and there has been considerable investigation of the effect of waves on beaches. Important work has also been done on internal waves in the sea, and on horizontal and vertical turbulence, which result in temperature, salinity and velocity differences much greater than those which had been foreseen.

The greatest advances in the study of the chemistry of the sea have been concerned mainly with nutritional relationships, and they have been associated with studies of the illumination and transparency of the sea. In these aspects this country has not been backward, because of the work done at Plymouth and Millport.

There are several indications that the study of oceanography may be entering a period in which it will receive as much, or more, support than it did after the last war. It must now be realized more than ever before that our future is intimately bound up with the sea, and the plans which have been put forward for the extension of its study should find the support they need. It is also inevitable after such prolonged and varied operations that naval authorities should show more interest in the subject.

There is not such a virgin field as in 1918, but we are better equipped to face more intricate problems. Not the least among our new assets are comprehensive text-books which we can read in our own language. On the other hand, we must remember with great regret the death of scientists who have keenly supported the subject, especially Dr. Kemp and Professor Stanley Gardiner ; and we must admit that many of the important developments before 1939, or even 1940, came from German oceanographers.

Much could be done to further the study of oceanography by encouraging mathematicians and physicists to study the sea. A well-known meteorologist, reviewing one of Sverdrup's books in this country, says that oceanography (meaning its physical aspect) is not a fashionable subject, nor does it obtrude itself to the notice of the physicist to any extent. This is no doubt true : marine biology is studied from the university laboratories because of its direct bearing on zoology, but only the most theoretical aspects of physical oceanography could be studied in this way, and the mathematical and physical studies make no demand for them. Where such an interest has been taken, professors have been obliged to hestitate before encouraging a student to study oceanography, because he would find it very difficult to earn his living in pursuing such work.

In addition to providing such facilities, there is need for the representation of the subject in some central institution. An eminent professor returning from a visit to Sweden during the war made it very plain to his audience that he had found in Sweden his first opportunity of becoming acquainted with physical oceanography. This is not a reflection on the value of the physical work done in this country, but an argument for its more prominent representation in a central institution, an advantage which it enjoys in many other countries.

To complete my share of the discussion, I ought to attempt to show which problems in physical oceanography need first attention, but I hesitate to do this without spending much more time on the question. I am, however, safe in urging one general requirement—the systematic examination of the North Atlantic Ocean. A great deal has been done in the Gulf Stream and in coastal areas on both sides of the ocean, but the main features of the water circulation and the balance between polar and tropical influences has not been studied on the same broad lines as it has by the Discovery Committee in the Southern Ocean.

There must be routine surveys of fishing grounds to provide data for correlation with fluctuations in the fisheries, but such data can be fully interpreted only when vessels have been to the distant parts of the ocean to study the physics, chemistry and biology of each type of water that may ultimately influence the local conditions. It is equally important to make long lines of observations across the boundary regions to assess the strength of each influence and the probable variations.

The problem is more difficult than that of the Southern Ocean, where there are well-defined Antarctic, sub-Antarctic and sub-tropical water masses, with clearly recognizable boundaries, and there is little doubt that continued work on the Southern Ocean will greatly advance our knowledge.

It is difficult to emphasise the needs of one aspect of the subject without tending to minimize its existing achievements and the needs of the other aspects. In conclusion, therefore, I shall suggest that the physical and chemical aspects have made rapid progress, and emphasise, as so many have done before, the close interrelation and mutual dependence of the various branches of oceanography as a whole.

Fertility of the Ocean.

By H. W. Harvey.

I SHOULD like to speak of a possible development of oceanographic survey. For many years it has been an aim to find how, and why, physical conditions in the sea fluctuate from year to year and over a period of years, particularly in regions where valuable fisheries are established. Marked fluctuations in the currents and the seasonal change in temperature are known to have occurred in some areas, also considerable fluctuations in the abundance of one or more species of animal and in the general fertility. Many instances are known where such physical changes have affected the population of the sea.

Changes in the waters occupying the mouth of the English Channel have been followed over a considerable period. In the nineteen years before the war the area has been washed out several times at quite irregular intervals; sometimes the water has been replaced with rather more saline and sometimes with less saline water, sometimes slightly affecting the seasonal change in temperature, sometimes not.

Only once has a replacement of the water, obvious from change in salinity and temperature, coincided with a marked change in fauna. Warm and more saline water came in during the autumn of 1921 and appeared to affect the migration of herring into the area. It appears that movement of the water masses and fluctuations from year to year in the seasonal change in temperature did not necessarily reflect changes in fertility of the region, because a great change occurred at the end of the 1920's which did not coincide with any noteworthy change in physical characteristics.

Quantitative net hauls have been made at weekly intervals over fifteen years by Mr. Russell. These show close relation between the phosphate in the water at the beginning of each year and the number of young fish spawned and surviving during the summer; also between this winter phosphate maximum and the general level of plankton population.

During the fertile years of the 1920's there was, at the beginning of each year, more than half as much again nutrient for plant growth as during the sequence of less fertile years in the 1930's.

As a result the plants supplied more grazing, and—I think we can still say ' as a result '—supported a greater animal population in the area.

It is of interest to consider what happens to combined phosphorus in the water throughout the seasons. Thanks to research by Redfield and others in the Gulf of Maine this is becoming possible.

In the winter most of the phosphorus is in solution as phosphate, a small fraction in animals and plants and a small fraction in solution as organic phosphorus compounds. In the Gulf of Maine about 90 per cent. of the total is in the form of dissolved phosphate by the end of winter. Thus the winter phosphate maximum is a fair index of the total phosphorus in body of water.

As the year progresses the plant growth in temperate seas utilises the phosphate in the upper layers and often reduces it to a very low level. They are never so numerous that they, themselves, contain more than a small fraction of the total, since the crop is being continuously eaten. Animal life increases with rapid production of zoo-plankton. Judging from estimations in the Gulf of Maine, plant and animal plankton may then contain some 10 per cent. of the total phosphorus, the remainder being in solution. The dissolved organic phosphorus increases enormously. It may be that some of this can be utilised again without breaking down to phosphate ; diatoms have been found to utilise phytin, a very stable compound widely distributed in plants.

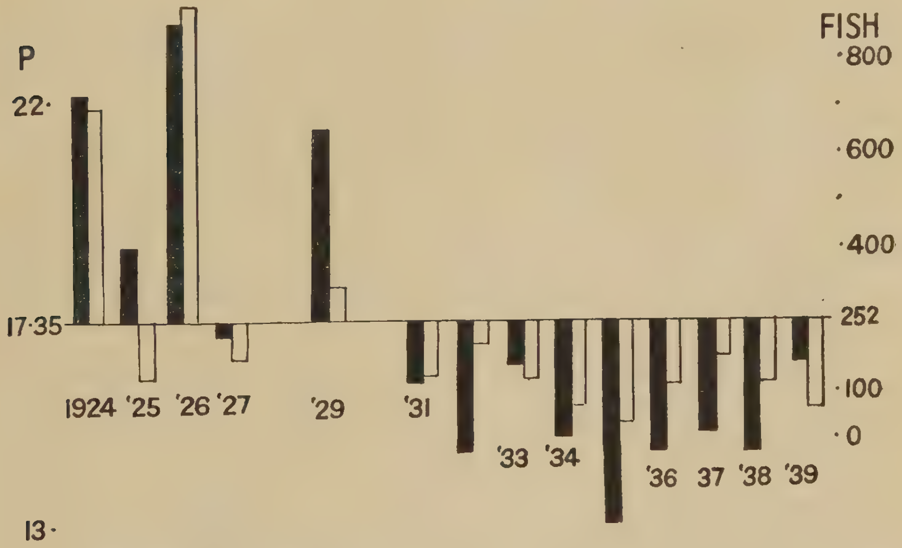


Fig. 1.—The black pillars show the concentration of phosphate in the water at beginning of each year. The outlined pillars show the average number of young fish caught per haul during the following summer ; these have been spawned during late spring and early summer and have survived the period of heavy mortality which occurs during their early life.

With the onset of winter the population of plant and animal plankton decreases, the rate at which phosphorus is being abstracted from the water is reduced, and the dissolved organic phosphorus slowly regenerates phosphate. In addition to that in solution and in the plankton there is also some in fish and bottom-living animals. This probably does not vary much throughout the seasons, and appears to be no more than a quite small proportion of the total.

We need a quick method, suitable for survey work, of assessing the total phosphorus in solution. Either this value, or that of the total combined nitrogen in solution, may well distinguish one body of water from another at any time of year in terms of their potential fertility ; just as the winter phosphate maximum appears to distinguish the actual fertility of the water occupying an area.

There seems to be a reasonable chance that development on these lines may provide a new tool, and allow water masses to be labelled in terms of their potential fertility.

It may provide an estimate of potential fertility but not of actual fertility, because regions differ the one from the other in the amount of turbulence in the water. The vertical component of turbulence plays a considerable role in modifying the general fertility of a body of water; it increases the production of vegetation by refreshing the photosynthetic zone with nutrients from below and hinders productivity by carrying a proportion of the breeding stock of plants down to depths with insufficient light for further growth.

There is a reasonable chance only of assessing potential fertility, because there seem to be other chemical factors affecting plant production, let alone that nice balance between plants and grazing animals necessary for maximum growth and use of the vegetation as food.

In nature the standing crop of phytoplankton, the breeding stock of plants, is continuously changing. The standing crop results from the *rate* the plants have been multiplying and the rate they are eaten. Rarely, it would seem, do these planktonic plants die—it is their usual fate to be eaten, before they reach the bottom in deep water. Growth of these plants can be very rapid. A single diatom has been seen to produce a million daughter cells in a week of continuous illumination.

In most seas the low concentrations of available nitrogen and phosphorus impose a brake on the rate of multiplication. In the Antarctic there is always ample, and here Hart has found that the plant population in the Scotia Sea is double that in other areas in the same latitude. The outstanding difference appears to be that water entering the Scotia area has washed outlying islands of the Antarctic continent and passed over a submarine ridge. He expects that the water has picked up a micro element, such as iron or manganese, en route, and that this accounts for greater plant production and more zooplankton.

In temperate seas there is also evidence that low concentrations of nutrients are not the only chemical factors which damp down the rate of multiplication.

Samples of water have been taken from the English Channel and from the sea off Japan, heated to kill the plants and animals, enriched with nitrate phosphate and iron, and inseminated with diatoms. In some samples these grew well, producing considerable crops, not in others. Indeed, in the Japanese experiments, no growth was made during four days of illumination in some samples of water. Thus, waters taken from different positions and depths differ the one from the other in their capacity to support diatom growth, and this is over and above that due to their content of nitrogen, phosphorus and iron. We don't know why. There is some evidence that the minute quantity of dissolved organic matter in the sea—about 5 milligrams per litre—plays a part in stimulating growth, and there is some evidence of inhibitory substances depressing the growth of both diatoms and bacteria.

Early last autumn it was noticed that a green flagellate, a *Chlamydomonas*, would not continue growth in water taken near the entrance to Plymouth Sound, which had been enriched with nitrate, phosphate and iron. It did grow and produce heavy crops in water taken about 20 miles off-shore and enriched in identical manner. Samples of in-shore water taken at intervals during the autumn and early winter all proved infertile towards this plant after enrichment. The addition of manganese rendered these in-shore waters fertile in every case. The addition of as little as half a milligram per cubic metre or one part in two thousand million allowed a heavy crop to grow in some samples, other samples needed the addition of rather more. These in-shore waters also proved infertile towards continued growth of three other species of autotrophic flagellates. The addition of manganese rendered them fertile to these also.

This early autumn in-shore water, after similar enrichment, would not allow the continued growth of a diatom—*Coscinodiscus*—although it grew reasonably well in off-shore water similarly enriched. The addition of manganese had negligible effect. Thus an essential for one group of plants, which may be insufficient in a sea-water, is not necessarily insufficient for other plants. Shortage of a micro-constituent such as manganese may not affect the productivity of the water, but merely hinder the growth of one group, other plants being able to take their place.

We have but little knowledge of the distribution of available iron or of manganese in ocean waters. As with organic phosphorus the difficulties of estimation have limited the collection of data. The distribution of manganese has additional interest, since deep-sea deposits are rich in this element, and some 12 milligrams are estimated to fall on each square metre of the ocean floor annually.

Marine Zoology.

By F. S. Russell.

To be asked to speak on Marine Zoology for twenty minutes is rather like being asked to speak on genetics for two minutes. I should think that marine zoology might claim a third, at least, of the territory of the whole science of zoology. So, rather than try to compress too much into too little, I shall limit myself to trying, in less than my allotted time, to put forward a suggestion or two which I hope may not fall on deaf ears.

The title of my contribution to this afternoon's discussion—Marine Zoology—implies that no distinction is drawn between zoology of our shores and shallow waters and zoology of the open ocean. I am myself of the firm opinion that the science of Oceanography must be regarded as embracing the study of all the seas of the world. With this outlook it is a natural corollary that the fringes of the oceans are as much the domain of the oceanographer as the deep oceans themselves.

I wish to stress this now, because my theme this afternoon will be more concerned with deep-water zoology. The growth of the science has followed the natural sequence common to zoology itself. Historically the earlier observations, at first along the shore and in shallow water, and later on ocean-going expeditions, were aimed at pure faunistic collecting. This was necessary, since the foundations of all branches of science consist of description and classification for purposes of future identification. In the sea this straightforward collecting of animals included the three main divisions of marine life, namely, the benthos, the nekton and the plankton.

In the process of collection for systematic purposes, records are kept of the place of capture. In time, numbers of pin-points accumulate on the maps for each species, which together lead to a knowledge of their geographical distribution. It is at this point that marine zoology makes its first contact with other branches of oceanography. Once enough pin-points have been accumulated to indicate the area inhabited by any species of animal, we want to know what the factors are which govern this distribution. And here, right at the beginning, we see how important it is that research in other branches of oceanography should go on concurrently, so that when the time is ripe the results of knowledge in more than one branch can be married. The zoologist, once he is interested in the causes of geographical distribution, asks what are the currents in the area in which he is interested, what are the physical and chemical conditions of the water, what is the nature of the substratum, and so on.

It is important to remember this need for advance on all fronts in an unrelated manner, because there is a tendency nowadays for some to think that physical oceanography, for instance, should be planned in relation to some biological problem. It is dangerous to plan too much. We cannot tell beforehand what new discovery is going to revolutionize our outlook. But the workers in the different fields should be in very close contact, so as to profit by one another's advances. For this reason it would be most satisfying if we could see the recently proposed oceanographical institute set up at Plymouth, so that the staffs of the two institutions could drop in to see one another frequently. After all, the Woods Hole Oceanographic Institution is situated near to the Marine Biological Laboratory. This was not a coincidence.

There is another side to the study of geographical distribution which calls for knowledge from even farther afield. Geologists must be called in to help. We ask, how is an animal's distribution related to the past history of the earth's configuration in connection with the phylogenetic relationships between animals in different oceans. The closer phylogenetic relationship shown between animals on the Atlantic and Pacific sides of the Panama Isthmus than between the east and west Pacific, is a good example.

Now, it can be fairly maintained that in the biological study of the sea the researches made in the marine biological laboratories in shallow waters have always been, and probably always will be, in advance of deep-water research. The development of research in the deep oceans has been largely the result of the extension of shallow water work farther afield. The systematics of marine animals and the study of their geographical distribution in relation to other factors are now well advanced. And, in passing, it might be recalled that the study of distribution was started in shallow waters by the pioneer work of Forbes, brought together in his Natural History of the European Seas.

The scope of work in marine laboratories since Forbes' time has been very much widened, and it is safe to say that during the years ahead the following will be the lines along which the chief advances will be made, and which will be most fruitful in their results.

Systematics and morphology are changing. Attention is now given to the treatment of samples of animals of any one species, rather than to individual specimens. We need to know much more about the variations in marine animals and their bearing on evolution ; in this respect our knowledge of land faunas is greatly in advance.

It is time that the study of clines or trends in variation from place to place was pursued more vigorously on marine animals, and that the chromosomes were examined to help in the discrimination of doubtful species. Most of the work on variation has so far been done on a few fish.

More work is needed on the life histories and development of marine animals. A good start has been made in in-shore waters, but oceanic animals offer a wide field. In recent years most interesting results have been obtained in this direction by the Danes, especially on the reproduction and development of molluscs in northern waters. These results have shown that a large number of arctic animals have no free swimming larval stages, or at most they have extremely brief larval periods in keeping with the brevity of the plankton seasons. This confirms earlier generalizations, and it is most desirable that observations should be extended to animals living on the floors of the deep oceans.

In the study of behaviour a beginning has been made in analysing the causes of vertical migrations of plankton animals in deep water, exemplified by the researches made by Clarke on the ***Atlantis*** in conjunction with measurements of submarine illumination. But there are other types of behaviour which offer almost a virgin field. We know very little about the swarming of animals in deep waters, or, again, about their feeding habits, or the inter-relationships between the different animals forming communities.

For some years now the physiology of marine animals has been a fruitful source of study in our laboratories. Practically no physiological researches have been made on oceanic animals. Here is a very wide field to choose from—digestion, respiration, respiratory pigments, secretion, excretion, osmotic regulation, coloration and luminescence, to mention a few—all calling for research. Much can be done in this direction by tempting the physiologist away from the land laboratories out to the open sea on board ocean-going ships. And here I might remark, that while such work can be done on board ship, the best work will be done in the laboratory, where all the necessary facilities are available. And, for this purpose, what more suitable place is there in the whole world than Bermuda? There, the deepest waters may be found within a few hours' steaming. We hope that more British zoologists and physiologists will avail themselves of the opportunities presented at the Bermuda laboratory.

I think I must have said enough to show that marine zoology is still only on the threshold of its career. It is true that a vast amount of work has been done—but the sea is a huge place, and most of the time so far spent in its study has been in the nature of spade work. While this essential work was being done, the science of animal physiology has been developing on its own. During recent years there have been great advances in knowledge and technique. The time has now come to knit the science of physiology with that of the marine zoology of the ocean. One of the greatest difficulties to be surmounted is probably that of keeping oceanic animals alive. All oceanographic expeditions of the past have brought back the bulk of their collections dead and pickled in bottles. I should like to suggest that the next step is to build or modify a ship so that it will be a great sea-going aquarium. Early in the war I believe the late Dr. Kemp and others had in mind the possibility of an expedition nearer home than usual, namely, over the deep water and continental slope west of Ireland. This idea has much to support it. Our universities—and museums—are still living on specimens of deep-sea animals caught in the early years of this century for demonstration purposes. It is time these were renewed by fresher specimens. There are also many interesting problems waiting on our doorstep. A quantitative study of the inhabitants of the deep ocean floor and of the continental slope still waits to be done. The area is also of interest in relation to the distribution of plankton indicators and their bearing on water movements in the English Channel and Irish Sea.

An expedition based so near home would form an ideal training ground for the oceanographers and biologists of the future, both for the Universities and the museums.

University lecturers would no doubt take the opportunity of a cruise to examine deep-sea life.

Should such an expedition prove a reality in the future, ought not one of its chief aims be to learn how best to keep deep-sea animals alive? It is certain that before our knowledge of the habits and physiology of deep-sea animals can really advance, this obstacle must be surmounted. That is why the laboratory is at present the most favoured haunt for research, because the animals used for investigations come from shallow waters and are easy to keep alive. Let us, therefore, have a floating aquarium filled with the most fascinating deep-sea animals, and I warrant no physiologist will keep away.

The British are an island nation, and love and respect for the sea are inborn. Let us see to it that in the study of the sea we keep a position in the world befitting such a nation. If we do not watch, there is a danger that we may drop behind. One of the smallest nations in the world, the Danes, holds a pre-eminent position in the science of marine zoology. Why is this? In great measure it is because the University museum staff at Copenhagen consists of men who have taken part, and are continually taking part, in oceanographical expeditions. We have many museums, and it should be possible to provide a steady flow of zoologists from museums to keep a vessel employed off our western shores. Let us hope that this, Dr. Kemp's idea, will be kept alive, and that once things are normal heads may be put together to bring it to fruition.

Oceanography and Fisheries.

By J. R. Lumby.

Of the various interesting aspects of the subject on which I am asked to speak, I propose to confine my remarks to one only—namely, the place which hydrology can occupy in a fishery research scheme.

When the war began in 1939, our organization at Lowestoft almost entirely disappeared, and our work came to an end. Building it anew has given us, I think, a splendid opportunity so to plan our hydrological work that the information we obtain will be most effective in increasing our understanding of the fisheries.

Sometimes in the past hydrologists and biologists have not always seen exactly eye-to-eye in this matter of the place of hydrology in fishery research, and there has recently been much discussion of the question. The chief complaint of the fishery biologist seems to be that hydrologists occupy themselves more with what is called ' pure hydrology ' than with fishery hydrology. To divide hydrology in this way is, I feel, making a distinction without a difference. Since it deals with the environment of the fish, all hydrological information has the inherent possibility of being necessary for understanding the behaviour of fish—although it may not be possible to assimilate this information at the moment. Iselin has said that pure hydrologists prefer to work in mid-ocean, because conditions are less complex there than in in-shore waters. Perhaps this is the real crux of the matter; if that is so, the difference resides in the place of the work and not necessarily in the nature of it. Accordingly, it seems that the justification for any particular hydrological investigation in a fishery research scheme is the extent to which the work is needed in solving a fishery problem. I think there can be no doubt that in a fishery research institution the chief aims of both hydrology and plankton work should be to provide information needed for the solution of fishery problems. Before hydrological investigations can be planned with this criterion in view, however, it is necessary for a clear answer to be given to the question : What do the biologists working on fishery problems want to know ? In one case I heard of, they said they needed no hydrological information. In another, they wanted to know everything about the sea; they demanded, for instance, a comprehensive description of the ' changing hydrological background '. Though their requirements in the first case are perfectly clear, in the second they are not sufficiently explicit for the formulation of a really practical programme. First of all, the amount of information that can be provided depends upon the resources available for obtaining it. This is a very important point, apt to be overlooked. It is, I believe, generally recognized now that the staff and equipment provided for hydrological work in this country have been on a meagre scale. The deficiency is not so much in capacity for collecting data, but in that for examining them. It is often the case, in my experience, that more data can be obtained than are digestible.

Secondly, I feel that this lack of precision in stating requirements for information has been the grit in the works from which springs the friction. The remedy which we are trying to introduce at Lowestoft lies in altering the way of approach, by directing more attention to attacking closely-defined problems than to carrying out general surveys having no precisely specified purpose.

To explain myself more clearly, may I digress into history for a moment ?

When the International Council for the Exploration of the Sea was first established, very little was known about the waters in which the Council was interested: there was practically a clean sheet to start work on. Research vessel surveys of the North Sea, Baltic Sea, and English Channel were therefore started, on which fixed stations were visited at regular quarterly intervals. These surveys were not designed for the investigation of any particular problem; they were merely intended to provide data which were later on to be used for getting a broad idea of the general conditions. This was undoubtedly a perfectly reasonable and proper procedure. After a while the complexities of these conditions became apparent, and quarterly cruises were felt not to be frequent enough (I think, by the way, that a special statistical study of this point might prove most enlightening). The continuity of the observations at the quarterly stations gradually broke down, and the 1914–18 war finished them completely. As a concomittant, co-operative work between the countries adhering to the Council also diminished.

Between the two wars there was a considerable development in organizing observations from commerical vessels, lightships, and so on. This development took place mainly in this country; it arose because research vessels could neither cover enough ground nor furnish sufficiently frequent observations. Such international co-operative work as was undertaken with research ships resolved itself into very elaborate cruises with several ships and with stations at very close intervals.

These later developments are, in my view, only extensions of the early surveys; they are intended to keep watch on hydrological conditions generally, and are not expressly designed for the investigation of clearly defined problems. When a problem arises, the action we are apt to take is to make a fresh collection of data without forming any precise plans for dealing with them when collected. There is, I feel, a significant difference between saying ‘ We want to test such and such an hypothesis; let us therefore get such data as we require for this purpose ’, and saying ‘ Let us collect data and then see what information we can get from them ’. I believe the time has now come when better progress can be made by following the first procedure. As far as I can see, most of the programmes recently proposed keep to the old system of somewhat incoherent surveys.

There are, I think, two drawbacks to this method in practice. First, so much of the available resources is spent on collecting the data that very little is left for their examination. Secondly, it does not seem to provide information which the fishery researcher wants, just at the present time, according to my experience. What the planktologist wants is another matter.

Whether at a later stage the fishery biologist will be able to arrange his information so that it is comparable with general hydrological events remains to be seen.

The type of problem on which I feel we might concentrate more of our attention may be illustrated by mentioning some of those that we have planned to study at Lowestoft.

The *first* is:—

> On the Bear Island grounds, in the Barents Sea, is the general fishing area that of mixed water? Is the fishing area at a given moment that of the mixed water at that moment?

Perhaps I may enlarge on this problem a little. The reason that we are interested in it at all is that the trawlers fishing the Bear Island grounds spend a proportion of their time looking for fish, and it is important that the time so spent should be reduced. The most probable explanation we know of at present is that the fish prefer the mixed water on the boundaries of the two currents prevailing in this region—as on the Grand Banks at Newfoundland. The current shown (Fig. 2) setting northward and eastward across the general region in which the fishing grounds lie, carries warm salt water from the southward and westward; that setting south-westward carries cold, less salt water from the north-eastward. The mixed water will lie along their boundaries.

If the hypothesis put forward proves correct, then the next steps will be to chart the courses of these currents in detail, to examine the extent to which their courses vary from time to time, and if necessary to provide some means by which the fishermen can tell, before they shoot their trawls, whether the water conditions are suitable or not. If the hypothesis is incorrect, we must think again.

Another question we want to study is this:—

> The interpretation of scales depends on 'winter' and 'summer' conditions being well defined in time. Is this the case in the waters beneath the thermocline in the northern North Sea?

We know that in some parts of the North Sea northward of the Dogger Bank, the temperature conditions are different in the upper 20 fathoms or so from what they are in the water below this depth. The seasonal range in the deep layer appears to be much less than in the upper layer, and the seasons somewhat displaced: in the lower water layer the temperature is highest in late autumn. We, therefore, have to chart the regions where these conditions apply and take account of them when scale readings are made for fish inhabiting these waters.

Other questions are:—

> Morphological differences between the stocks of herring may be due to environmental influence; do the different stocks (as eggs and larvæ) have distinct differences in distribution and environment?

And:

> Do discontinuity layers inhibit the vertical movements of herring?

It is clear that the solution of problems such as these demands a high degree of co-operation between hydrologist and biologist. I feel that concentration on them will help to keep workers on the two sides much closer together than hitherto, and that the necessarily sharper focusing of ideas will be mutually beneficial. We hope that in this way we shall effect a better economy of our resources, and also be able to bring into use data already collected and published. When a number of such problems has been propounded and satisfactorily answered, then, I think, we shall have prepared a sure foundation from which we can proceed to study the more general problems such questions as the natural fluctuations in fish populations, for example, By studying the pieces of the jig-saw more intensively, we may find we can fit them together more surely than when we pick them up at random.

I should not like it to be thought, however, that I consider that general surveys, this watching of conditions generally, should be quite abandoned. What I believe is that we should be careful to hold a proper balance between the effort expended on surveys and that expended on attacking specific problems. At present the balance seems to come down heavily on the side of surveys, and it is my hope that this may be corrected to some extent. If surveys are to be enlarged, then a more generous provision of staff and equipment is indispensable for effective use to be made of the data collected.

Even with surveys, I think they may prove more fruitful of useful information if they are planned with some quite definite object in view, and if, before the observational work is put into operation, a decision is reached on the methods by which the data will be examined.

In our case, at Lowestoft, we are reducing the scope of our survey work very considerably from its pre-war extent. The series of observations which we are now starting have perfectly clear objects in view. Those on the Newhaven–Dieppe route, for example, are to give warning of the approach of water of very high salinity to the southern North Sea—either as a surface or a sub-surface flow. We plan to have a line across the central or northern North Sea for a like purpose.

Other institutions interested in oceanography in both this and other countries will no doubt be undertaking similar work. The value of this work will be enhanced, I believe, if it is well co-ordinated, and also if plans are made to deal effectively with the data obtained.

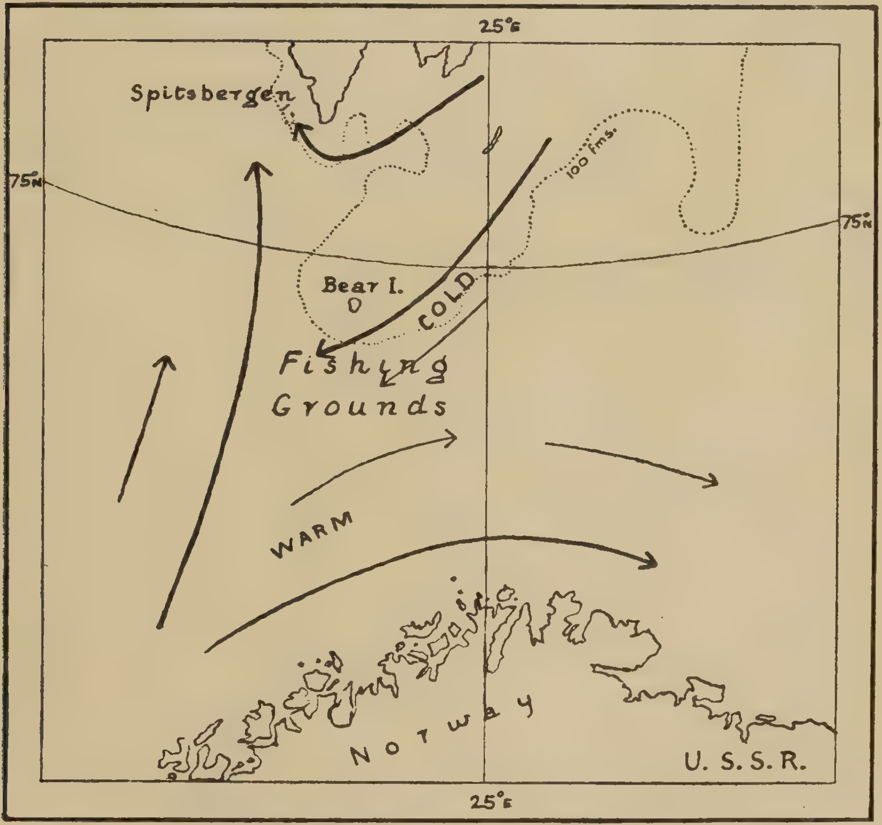


FIG. 2—Sketch Chart showing the Currents and Fishing Grounds in the vicinity of Bear Island.

Discussion.

In the discussion that followed the papers, Vice-Admiral Sir John Edgell, K.B.E., C.B., F.R.S., Dr. J. N. Carruthers, Dr. Johan Hjort, and Dr. H. Blegvad took part; and Mr. Henry G. Maurice made some concluding remarks.

Dr. J. N. CARRUTHERS, Hydrographic Department (Oceanographical Section), Admiralty,—

I am sure that all oceanographers here present will wish that a warm expression of thanks be made to the Linnean Society for having staged this excellent symposium, which has made it possible for the views of four experts on a subject of ever-increasing interest and importance to become so usefully known to a wide circle.

Dr. Deacon mentioned Germany, and naturally referred to the advances made in that country amongst others. As yet, no representative body in Britain has asked the Admiralty for information regarding the present state of matters oceanographical in Germany, and I have no warrant to go into detail on this occasion, though certain things can be said without impropriety. Firstly, as to the matter of the important German oceanographical libraries: those of the Deutsche Seewarte and of the Institut fuer Meereskunde zu Berlin have been saved, and are in the charge of experts within an organization set up in Hamburg under official sanction. I make bold to believe that what has been done with the numerous German workers in the field of marine research, would meet with the approval of such a meeting as that which I now have the privilege of addressing. As to the researches carried out by the German oceanographers during the close years, in so far as these have been written up in the pages of the 'Annalen der Hydrographie, usw.', of 'Der Seewart', and of the 'Archiv der Deutschen Seewarte usw.', the Hydrographic Department of the Admiralty will, I fully expect, do whatever may be possible to make them known—for a set of these journals is in my keeping. Naturally, many papers have appeared in various other series of publications, and many in books and pamphlets of a confidential nature—but I shall hope, with the progress of time, to be of help in making various papers known. Dr. Deacon rightly expressed pleasure at the appearance in recent years of text-books on oceanography in the English language. There are also new, though less ambitious ones in other languages, and I must mention that Professor Albert Defant has, during the war years, written rather a monumental one running to three volumes. I have made the Contents List of this known to British, American and Scandinavian oceanographers. As yet, it is in typescript only, but consideration is being given to the thought of getting it printed.

I feel, myself, very strongly in sympathy with what Lieut.-Commander Lumby has so forcefully said as to the rational application of effort in the carrying out of oceanographical researches. Nobody concerned with studies upon life in the Sea would think of disputing the view that we need to learn everything possible about the ambient medium—that, in fact, there is little knowledge about the sea itself which we can afford to leave on one side as not well worth seeking. None-the-less, resources and facilities being limited, it is, in my view, an eminently sound practice (and is not 'unscientific') when planning researches, to provide for preferential attention to lines of work designed to yield the information we *most* wish to have. We cannot gather in all knowledge; let us decide in advance what we *most* need to know, and scheme our investigations accordingly. The price of not doing so is dissipation of effort, whether we like to admit it or not. The mere piling-up of data may be impressive, but is by no means necessarily a good thing. The modern oceanographer needs an adequate office organization behind him: this is vital indeed! The effective pursuit of his calling is bound up with the possession of card indexes, and of extensive collections of data carded in keeping with sound methods. Lieut.-Commander Lumby is very much at home in these important matters. He (Lieut.-Commander Lumby) has talked to us about oceanographical factors which need study in connection with fishing in the waters of the Barents Sea, and this links up with the very important matter of 'Polar Warming'. As is well enough known, the Arctic region experienced an accession of temperature in recent years: since the winter of 1918/19 the Spitzbergen area was considerably less cold than in earlier years. The severe winter of 1928/29 broke into the period of 'warming-up', but, since then, a new wave of warming supervened. The peak winter of 1938/39 was (in the Spitzbergen region) 17° C. warmer than was winter 1916/17. Since then there has been a retrogression, though even winter 1941/42 was apparently some 5° C. warmer than the cold seasons of some thirty and more years ago.

Very important economic matters in the fishery connection link up with this question of water temperature in the northern seas, and just before the war it was receiving much attention. During the war it has received a measure of attention in German literature, and I shall hope to make known a relevant paper by Dr. Weichmann.

I wish to thank the four speakers for their stimulating and very interesting addresses.

Dr. JOHAN HJORT, F.M.R.S., President, International Council for the Exploration of the Sea, stressed the importance of simultaneous biological and physico-chemical observations, such as can be carried out by using series of plankton nets, water-bottles and reversing thermometers at corresponding depths.

Dr. H. BLEGVAD, Director, Danish Biological Station, and General Secretary, International Council for the Exploration of the Sea: I am very grateful to have been invited to listen to the four very interesting papers which we have just heard. Being chairman of a sub-committee under the International Council for the Exploration of the Sea, having the purpose of encouraging closer contact and better co-operation between the hydrographers and the marine biologists, I have taken a special interest in what we have heard to-night on the problems to be solved by such a co-operation.

There is, however, one thing I should like to emphasize in this connection, which is the following :—

We do know that if, *e.g.*, a cod spawns a million eggs, only a few individuals will survive. We also know that the main part of this enormous mass of germs of life perishes at a very early stage ; but why, and exactly when, we do not know. Therefore it seems to me that it would be worth while to follow up the idea originally put forward by my colleague and friend, Mr. F. S. Russell, that hydrographical and biological investigators on board a ship should study a specific mass of water during a considerable period, making repeated investigations of the life in the water and the hydrographical conditions.

If such an experiment could be carried out, *e.g.*, in the southern part of the North Sea, it would be possible to follow a mass of water carrying new-laid batches of fish eggs. The alterations in the hydrographical conditions and the subsequent number of fish eggs and larvae could be studied. It is possible that thus we might get at least some information on the great problem, Which are the hydrographical conditions that determine life or death for the young fish, and at which stage of the life of the young fish do they set in ?

PROCEEDINGS OF THE GENERAL MEETING ON 4 April 1946

Colonel F. C. STERN, O.B.E., M.C., Vice-President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 21 March 1946 having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Dr. Kaj Berg, The Lady Isabel M. P. Browne, Dr. O. R. Gurney, Capt. Eric Hardy, the Zoological Society of London and the Forest Department, Kuala Lumpur, F.M.S.

In accordance with Chap. 10, Sect. 8 of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer's accounts for 1945–46 :—

Representing the Council : Mr. A. A. Pearson.
Mr. A. H. G. Alston.

Representing the Fellows : Mr. I. H. Burkill.
Mr. D. J. Scourfield, I.S.O.

Read for the first time certificates of recommendation of the following candidates,—

Fellowship.—Gerald Mortimer Ash, Sir Nigel Gresley Ball, Bt., M.A., Sc.D., Rear-Admiral Tufton Percy Hamilton Beamish, C.B., G. D. Bhavnani, M.Sc., Winifred M. A. Brooke, Robert Brown, D.Sc., Laurence Chalk, Earle Leslie Davison, Douglas Dawson, William Ernest Dick, B.Sc., Alan Robertson Gemmell, B.Sc., Ph.D. (Glasg.), M.S. (Univ. Minnesota), Prof. T. H. Goodspeed, Ph.D., Frederick Cyril Grigg, Sydney Cross Harland, D.Sc. (Lond.), F.R.S., Daniel Darius Haynes, Idris Valentine Hunt, M.Sc., Harold Augustus Hyde, M.A., Chester Jones, B.Sc., Ph.D., Frank Whitwam Jones, M.A. (Cantab.), Norman Sumner Jones, M.Sc., Major Maxwell Knight, O.B.E., Major Oscar Martin Lee, R.A.S.C., Margaret Alice Palmer Madge, B.Sc., Ph.D., William Marshall, B.Sc. (Edinb.), Harold Philip Moon, M.A. (Cantab.), Herbert Francis Mooney, O.B.E., E.D., M.A., Sc.D. (Dublin), Frank Robert Mumford, B.Sc., John Dean Palmer, Colonel Robert Bernard Phayre, M.C., John Leslie Rees, Miss Catherine Muriel Rob, Promode Kumar Sanyal, B.Sc., Ph.C., Brigadier Henry Gilbertson Smith, Herbert Stone, Herbert George Stubbings, M.A., Ph.D. (Cantab.), B.Sc. (Lond.), Major Patrick Millington Synge, F./Lieut. Roland Mark Underhill, B.Sc., David Henriques Valentine, M.A., Ph.D., Errol Ivor White; D.Sc., Ph.D., Sydney Renoden Wycherley.

Foreign Membership.—Professor Jan Bělehrádek, Rector of Prague University ; Prof. H. Boschma, Director, Natural History Museum, Leiden ; Dr. Josias Braun-Blanquet ; Prof. Edouard Chatton ; Dr. François Gagnepain ; Prof. Johan Hjort, President, International Council for the Exploration of the Sea ; Dr. N. A. Maximov, Director, Institute of Plant Physiology, Moscow ; Knud Hensch Stephensen, M.Sc., Zoological Museum, University, Copenhagen ; Dr. Victor van Straelen, Director, Natural History Museum, Bruxelles ; Prof. Johanna Westerdijk, Centraalbureau voor Schimmelcultures, Baarn, Netherlands.

Associateship honoris causa.—Mr. Frederick James Pittock.

Associateship.—Herbert George Baker, B.Sc., Ph.D., Anthony Brian Lowsley Peake, and Geoffrey Harold Satchell, B.Sc., Ph.D.

The following communications were read and discussed,—

> Prof. J. McLean Thompson. A Contribution to Knowledge of the Roots and Root-bearing Organs of the Forsythias. (Discussed by Mr. I. H. Burkill, Dr. E. M. Delf, and Dr. R. Melville ; Prof. McLean Thompson replied.),

Abstract.—

The communication dealt, in the first place, with the origin of rhizomorphs upon the pendulous shoots of *Forsythia suspensa* and upon upright branches of *Forsythia intermedia*. Alternative modes of development of these organs were

described in witness of their indeterminate state. A preliminary account was given of their simplest morphological variations and of their main histological peculiarities. In the second place, it was shown that the rhizomorphs may develop as roots and may give rise to either roots or rhizomorphs, according to their growth-conditions.

The statement was a preliminary one, presenting facts such as may be required by physiologists and horticulturalists engaged in the study of propagation.

Discussion.—

Dr. E. M. Delf asked whether the author had considered any physiological possibilities, such as the part played by Auxins or other growth substances in the development of the rhizomorphs.

Dr. W. G. Templeman. Plant Growth Substances as Selective Weed-killers. (Discussed by Dr. M. A. H. Tincker.)

Mr. F. J. D. Thomas. The New Insecticides, 'Gammexane' and D.D.T. (Discussed by Lt.-Col. W. P. C. Tenison, D.S.O., Dr. W. E. Brenchley, Mr. E. Robinson, Dr. R. Melville; Mr. Thomas replied.)

Abstract.—

In this talk a general survey was given of the position of the new insecticides, D.D.T. and 'Gammexane', in relation to the older insecticides and to possible future insecticide developments. The lecturer pointed out that although considerable differences existed between the two new materials, they had considerable points of similarity, particularly in the marked advances they represented over any insecticides previously known. Both insecticides could kill insects by contact, and this property could persist for a considerable period. Previous contact insecticides were mainly transitory in action. Both materials could also act as stomach poisons, while 'Gammexane' could act also as a fumigant. Surveying insecticides type by type, the *contact* insecticides were first considered. Older materials included derris, nicotine and pyrethrum —all natural products and hence subject to variation, and one (nicotine) very poisonous to man. Derris, largely used in agriculture for the control of caterpillars, beetles and aphides, seemed particularly likely to be replaced except perhaps with regard to aphides. Nicotine might suffer less, since it was largely used against aphides, and in general the new synthetics had shown less promise against pests of this group, although improved formulations might increase their effectiveness and 'Gammexane' in particular was proving effective against at least some species. With pyrethrum, the last contact insecticide to be considered, the position was different in that this material was largely used for the control of pests of stored products and carriers of human disease, and had hence felt the full impact of the new materials, particularly, so far, D.D.T., which during the war had achieved spectacular control of pests such as mosquitos, flies, lice, and bed bugs. This control, as regards adult flies and mosquitoes, was achieved firstly by direct spraying of the adults as pyrethrum had been used, then by utilizing the residual contact effect of the new material by spraying walls, etc. to leave a film to kill any visiting insects, and finally the new materials were being incorporated into paints, distempers, etc. to provide a semi-permanent toxic film.

The nature of the new insecticides had also permitted the fuller development of another mode of application, aimed at reducing the labour required for treatment to a minimum. These were the new thermal generating devices, consisting of a heater mixture blended with the insecticide. On ignition these provided an insecticide cloud which effectively disinfected the entire room, and subsequently left a toxic deposit on exposed surfaces.

Pyrethrum still retained one advantage—its power of almost instantaneous knockdown as a direct spray. For this reason fly sprays would probably continue to include some pyrethrum.

The new materials had also shown high promise in the veterinary field against many of the major pests of animals, such as lice, keds, ticks, sheep blowfly and mange.

Considering the stomach insecticides, the chief materials were the arsenicals and fluorine compounds, used in the agricultural field for the control of caterpillars and other chewing insects. Here again the new insecticides strongly challenged the old, often probably acting primarily as contact poisons and providing by their residual action that degree of protection to the crop previously only obtainable by coating it with a stomach poison. This had the advantage that the insect need not necessarily take its toll of the crop before it died. The new materials could also use their stomach poison powers, as shown by the striking success of ‘ Gammexane ’ as a locust bait.

Another type of insecticide, the oil sprays, seemed at the moment likely to be much less affected by the new materials than the groups so far considered. Oil sprays, together with HCN fumigation, were widely used against scale on citrus, etc. and while the position was by no means clear, it seemed likely they might hold their own. Oil sprays of various types also find considerable use as ovicides, and so far the new insecticides had not shown much promise as ovicides. They might, however, take the place of ovicides, by remaining as a persistent toxic coating on or near the egg, killing the young insect at emergence.

The last type of insecticide considered was the acaricides, and here neither material has so far shown promise against the fruit tree red spider, but ‘ Gammexane ’ had shown high effectiveness against certain parasitic acari.

The new materials were also controlling pests hitherto regarded as invulnerable. Examples were the Apple Blossom Weevil and the wireworm. Current trials indicated that the latter could be controlled with very small doses of ‘ Gammexane.’

Summing up, the new materials were permanently replacing the old in many applications, and finding new uses of their own. Cost/efficiency ratios would be the deciding factor in some cases.

In the immediate future we would see a decade or two of further intensive research with D.D.T. and ‘ Gammexane ’, leading to an expansion of their use in all fields, but that research was unlikely to solve all our insecticide problems. We were already becoming aware of their points of weakness, as ovicides, as acaricides, in some cases as aphicides and scalicides. Some improvements might be made by improved formulations, but even so, probably considerable gaps would remain.

They also tended to be too effective, in that they killed friend and foe alike. This did not matter in indoor applications, but it was advantageous in agricultural applications to be able to kill the pest but leave parasites and predators unharmed. There was thus likely to be an increasing search for more selective insecticides.

Specificity of this kind, depended on timing and on formulation, as well as active ingredient as regards the chemical, and on an intimate knowledge of the structure and habits, both individually and in their inter-relations, of the insect community concerned. It was, therefore, going to take a long time to achieve perfect control along these lines, when each insect complex must be approached as a fresh problem.

An ultimate development of the application of insecticides to the soil to proof the growing crop could also be foreseen ; this had of course already been done experimentally, and besides having obvious possibilities for selective action, it solved many worries of application.

It was therefore improbable that the latest developments represented finality, but the fact that they had almost been described as such was a measure of the enormous advance they represented and we could certainly look forward to them being invaluable for many years to come.

Discussion.—

Lt.-Col. W. P. C. TENISON said that whilst thanking Mr. Thomas for his most interesting paper, he felt considerable qualms at the prospect of a wide use of these powerful insecticides. He wondered what the position of a bee-keeper would be who lost all his bees through the lavish use of these persistent poisons by his neighbours. Surely their use against the apple blossom weevil would also kill the insects necessary for the setting of the fruit. He wondered, too, what value there could be in developing selective formulations that would destroy pests and not their predators. In this case it would seem that these latter allies to husbandry would disappear through starvation.

Dr. W. E. BRENCHLEY remarked that, with reference to the remarks of the last speaker, the same problem has arisen at Rothamsted, where there is a Bee Research Station. In view of the risk involved special precautions are to be taken in view of the proposed use of ' Gammexane ' for the control on turnip flea beetle. Danger would arise if charlock or other weeds were if flower at the time of dusting, otherwise there would be nothing to attract bees to the areas involved.

Mr. E. ROBINSON asked whether when plants have been sprayed with D.D.T. and the material has had time to dry does it remain effective on the plants after rain or is it easily washed off ? Perhaps Mr. Thomas will also tell us for how long, after being applied to plants in the open air, the insecticide retains its potency ?

Dr. R. MELVILLE enquired whether the new insecticides were effective against the common garden pests slugs and millipedes, and if so was there any advantage over the use of " Meta " against slugs.

Mr. THOMAS, in answer to questions, stated that the relationship of structure and toxicity was still obscure. In the case of ' Gammexane ', the structural similarity to Inositol had been noted, and a ' blocking ' action postulated, while Dr. H. Martin had advanced his theory of dehydrochlorination to cover the action of both new insecticides. According to this theory, they possessed the essential property of penetrating into the insect, travelling to the site of action and there releasing HCl. With regard to the effect of the new materials on bees, every care of course must be taken, but there was no reason to suppose that the new materials would be more dangerous than the old if properly applied.

PROCEEDINGS OF THE GENERAL MEETING ON 9 May 1946

Colonel F. C. STERN, O.B.E., Vice-President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 4 April 1946, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Professor Maurice Caullery, Mr. K. C. Corsar, Dr. G. E. R. Deacon, Captain Eric Hardy, Mr. W. R. Le Fanu, Miss E. F. Noel, Dr. G. S. Puri, Dr. G. Rudorf, Mr. S. Savage and the British Council.

The following Fellow signed the Obligation in the Roll and Charter Book, and was admitted a Fellow,—Dr. John Francis George Wheeler.

Read for the second time certificates of recommendation of the following candidates,—

Fellowship.—Gerald Mortimer Ash, Sir Nigel Gresley Ball, Bt., M.A., Sc.D., Rear-Admiral Tufton Percy Hamilton Beamish, C.B., G. D. Bhavnani, M.Sc., Winifred M. A. Brooke, Robert Brown, D.Sc., Laurence Chalk, Earle Leslie Davison, Douglas Dawson, William Ernest Dick, B.Sc., Alan Robertson Gemmell, B.Sc., Ph.D. (Glasg.), M.S. (Univ. Minnesota), Prof. T. H. Goodspeed, Ph.D., Frederick Cyril Grigg, Sydney Cross Harland, D.Sc. (Lond.), F.R.S., Daniel Darius Haynes, Idris Valentine Hunt, M.Sc., Harold Augustus Hyde, M.A., Chester Jones, B.Sc., Ph.D., Frank Whitwam Jones, M.A. (Cantab.), Norman Sumner Jones, M.Sc., Major Maxwell Knight, O.B.E., Major Oscar Martin Lee, R.A.S.C., Margaret Alice Palmer Madge, B.Sc., Ph.D., William Marshall, B.Sc. (Edinb.) Harold Philip Moon, M.A. (Cantab.), Herbert Francis Mooney, O.B.E., E.D., M.A., Sc.D. (Dublin), Frank Robert Mumford, B.Sc., John Dean Palmer, Colonel Robert Bernard Phayre, M.C., John Lelsie Rees, Miss Catherine Muriel Rob, Promode Kumar Sanyal, B.Sc., Ph.C., Brigadier Henry Gilbertson Smith, Herbert Stone, Herbert George Stubbings, M.A., Ph.D. (Cantab.), B.Sc. (Lond.), Major Patrick Millington Synge, F./Lieut. Roland Mark Underhill, B.Sc., David Henriques Valentine, M.A., Ph.D., Errol Ivor White, D.Sc., Ph.D., Sydney Renoden Wycherley.

Foreign Membership.—Professor Jan Bělehrádek, Rector of Prague University; Prof. H. Boschma, Director, Natural History Museum, Leiden; Dr. Josias Braun-Blanquet; Prof. Edouard Chatton; Dr. François Gagnepain; Prof. Johan Hjort, President, International Council for the Exploration of the Sea; Dr. N. A. Maximov, Director, Institute of Plant Physiology, Moscow; Knud Hensch Stephensen, M.Sc., Zoological Museum, University, Copenhagen; Dr. Victor van Straelen, Director, Natural History Museum, Bruxelles; Prof. Johanna Westerdijk, Centraalbureau voor Schimmelcultures, Baarn, Netherlands.

Associateship honoris causa.—Mr. Frederick James Pittock.

Read for the first time a certificate for Associateship in favour of Mrs. Hilda Mabel Canter, B.Sc.

The following candidates were balloted for and elected Associates:—Herbert George Baker, B.Sc., Ph.D., Anthony Brian Lowsley Peake, and Geoffrey Harold Satchell, B.Sc., Ph.D.

The following communications were read and discussed:—

Prof. Walter Garstang. The making of a Polyp: a study in phylogeny. (Discussed by Dr. S. M. Manton.)

Dr. C. B. Williams. (*a*) The Logarithmic Series and the comparison of Island Floras; (*b*) A diagrammatic method of analysing the interrelationship of the Fauna or Flora of several different localities. (Discussed by Dr. E. M. Delf, Mr. A. W. Exell, Mr. A. J. Wilmott.) [Printed in full, below.]

Dr. E M. Delf. Reproductive mechanism in the Fucales.

The Fucales comprise two major families, the Fucaceae and the Sargassaceae, the latter predominantly in the southern hemisphere. The fucoids are chiefly intertidal, the sargassoids mostly sub-littoral.

In both families reproduction is by means of passive eggs of slightly greater density than sea-water and some 3,000 times larger than the small active spermatozoids. Both kinds of gametes are shed into the water.

In both families the eggs and sperms are produced in deep cavities, the conceptacles. In escaping, the egg or sperm must be released from the wall of the mother cell as well as from the confined cavity of the conceptacle. The mechanisms of this escape are not well understood, especially with regard to the eggs.

Some evidence can be obtained by the study of the developing oogonium. Until just before maturity, the wall is very thin ; but then mucilage appears between the thin outer wall and the living contents, either surrounding the latter (as in *Fucus*) or forming a pad at the distal end, as in many sargassoids, where also there is but one egg in each oogonium. The distal mucilage appears to play a part in the escape of the egg and also holds it in place, just outside the ostiole. Fertilization is known to occur in *Sargassum* while the egg is thus held, and sporelings also form before the mucilage disappears.

The mechanical problems in these two types are discussed, and some suggestions are put forward to account for the process of fertilization taking place under these very different circumstances.

Papers were read in title :—

'On new and rare British Spiders'. By A. F. MILLIDGE and G. H. LOCKET. [Printed in full, below.]

'Synopses of the British Fauna.—No. 4. Freshwater Bivalves (Mollusca). *Dreissena, Corbicula, Sphaerium*'. By A. E. ELLIS, M.A., F.L.S.

'An account of some abnormal plants of *Salvia Verbenaca* L. and *S. pratensis* L.'. By D. A. COULT, M.Sc., F.L.S. [Printed in the Journal, Botany.]

'A revised classification of Leptosporangiate Ferns'. By R. E. HOLTTUM, M.A., F.L.S. [To be printed in the Journal, Botany.]

A DIAGRAMMATIC METHOD OF ANALYSING THE INTER-RELATIONSHIP OF THE FAUNA OR FLORA OF SEVERAL DIFFERENT LOCALITIES.

By C. B. WILLIAMS, Sc.D.

(Rothamsted Experimental Station, Harpenden.)

If we have a reasonably complete list of the species in some group of animals or plants which are known to occur in two or more localities under consideration, it is of interest to analyse these species into those which occur in one locality only ; or in another ; or in two or more selected localities. Except in the very simple case of two localities, where there are only three possible groups—it is not easy to keep in mind a clear idea of the relationships. As a result of some work on these lines I have designed the following diagrammatic method of showing the relations for up to six separate localities and hope that they may be of interest and help to other workers.

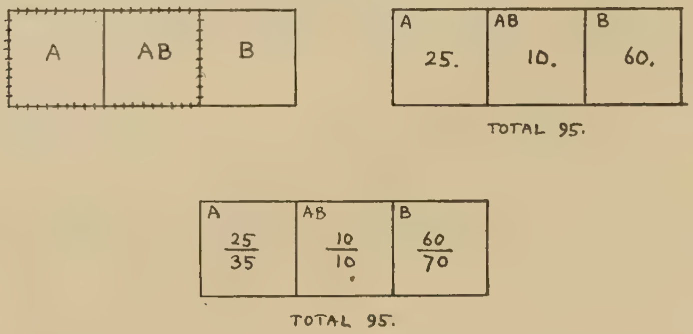
The simplest case :—Comparison of two localities.

If we have a list of the species of plants (or birds or any other group) from two localities A and B,—for example two islands—then the component species can be analysed into three groups. Those found in A only ; those found in B only ; and those found in both A and B. If a rectangle be used to represent the total number of species in the two localities (fig. 1, A) it can be divided into three smaller rectangles with number of the species only in A at one end, the species only in B at the other end, and those common to the two in the middle. It would be possible to make the actual area of the rectangles proportional to the number of species, but at least for comparison with the more complex diagrams I find it simpler to write in the rectangles the number of species concerned (fig. 1, B). In this (imaginary case) we have assumed that there are in the two localities 95 species of which 25 are found only in A, 60 found only in B and 10 common to both.

It will be noted that the number 25 in A is the number which occur in A excluding those which occur also in B—for this reason we will call it the ' exclusive ' number.

We also want to have easily available the total number in A *including* those also found in B ; this we call the " inclusive " number. In the present diagram it is easily obtained by adding the A number 25 to the AB number 10 and is therefore 35. But in some of the more complex diagrams it is not so easy to obtain, so I have completed the diagram by putting in each area the two numbers, exclusive and inclusive, in the form of a fraction (fig. 1, C). The upper figure is the number of species that are found in that locality or combination of localities and nowhere else in the area under consideration ; and the lower figure is the total number that are found in that combination of localities even if they are also found elsewhere. Thus from the right-hand rectangle in fig. 1, C we infer that of the 70 species found in the locality B, 60 are found in B alone, and not in A.

FIG. 1.



This is the simplest form of diagram.

The case of three localities.

If we have a list of the species in three localities A, B and C, we can analyse them into seven different groups :

in A only,
in B only,
in C only,
in A and B, but not in C,
in A and C, but not in B,
in B and C, but not in A,
in all three localities A, B and C.

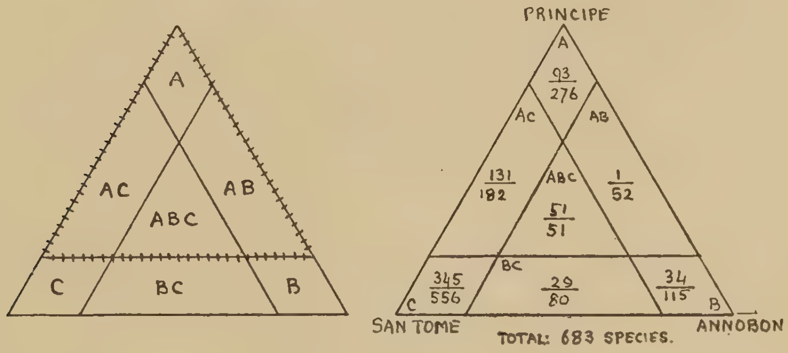
Any one locality A is represented in four of these groups :—A, AB, AC and ABC.

Diagrammatically this can be represented by fig. 2, A which shows the seven different groups. The four areas including the locality A are shown by the smaller triangle with cross-hatched edges.

Fig. 2, B, shows a similar figure filled up with the number of species (both 'exclusive' and 'inclusive') of flowering plants on three West African Islands of Principe, São Tomé and Annobon (data from Exell, Catalogue of Vascular Plants of São Tomé, London, 1944).

From the diagram we can see immediately that Principe (A) has 276 species of plants of which 93 are not found in either of the two other localities. From the division AB (middle right-hand side) we see that there are 52 species common to both Principe and Annobon (B) but only one of them is not also found on São Tomé (C). In fact 51 of these 52 are found on all three islands as shown by the centre triangle ABC. Similarly, there are 80 species common to both São Tomé and Annobon but only 29 of these are not found on Principe; and so on

FIG. 2.



The case of four localities.

If four localities A, B, C, D, are being compared there are fifteen possible classes as follows :—

A
B
C
D
AB
AC
AD
BC
BD
CD
BCD
ACD
ABD
ABC
and ABCD

Of these any one locality A is represented in eight groups:

A
AB
AC
AD
ACD
ABD
ABC
and ABCD

It is not possible to make a straightforward diagram to represent this condition, as theoretically it should be solid tetrahedron in three dimensions. But by a slight compromise fig. 3, A has been designed which gives a complete analysis of the groups, with the only fault that two of these, AC and BD, have had to be repeated twice. These have been specially marked to show this. Apart from this all the 15 groups are present and all the eight groups relating to locality A are in one block as shown surrounded by the cross-hatched line.

Fig. 3, B, shows an actual example of the use of the diagram for the flowering plants of four West African Islands, three of which are as in fig. 2, but with the addition of a fourth island, Fernando Po (data also from Exell, *l.c.*).

An examination of this diagram shows for example that :—(A) the Island of Fernando Po has 826 species of flowering plants of which 613 are not found in any of the other three ; (ABCD) there are 33 species found on all four islands ; (BCD) there are 51 species found on Principe (B), São Tomé (C) and Annobon (D), but of these only 18 are not found also on Fernando Po ; (CD) 80 species are common to São Tomé and Annobon, and of these 17 are not found elsewhere in the areas under consideration ; and so on.

Fig. 3.

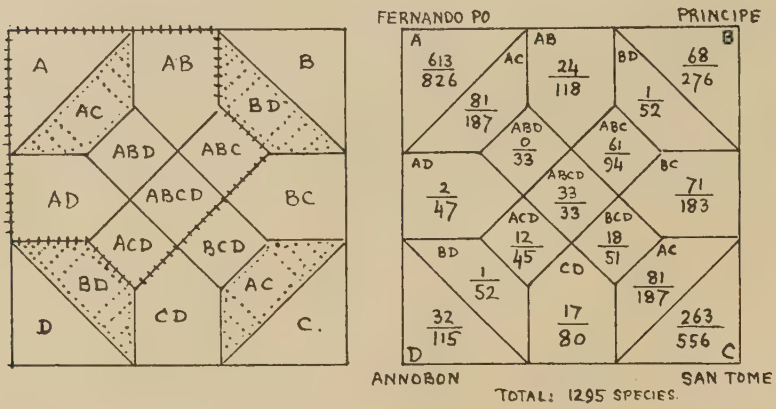
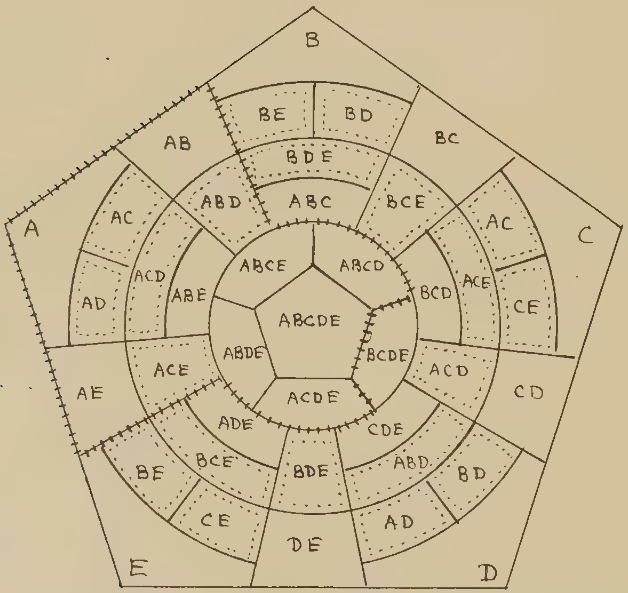


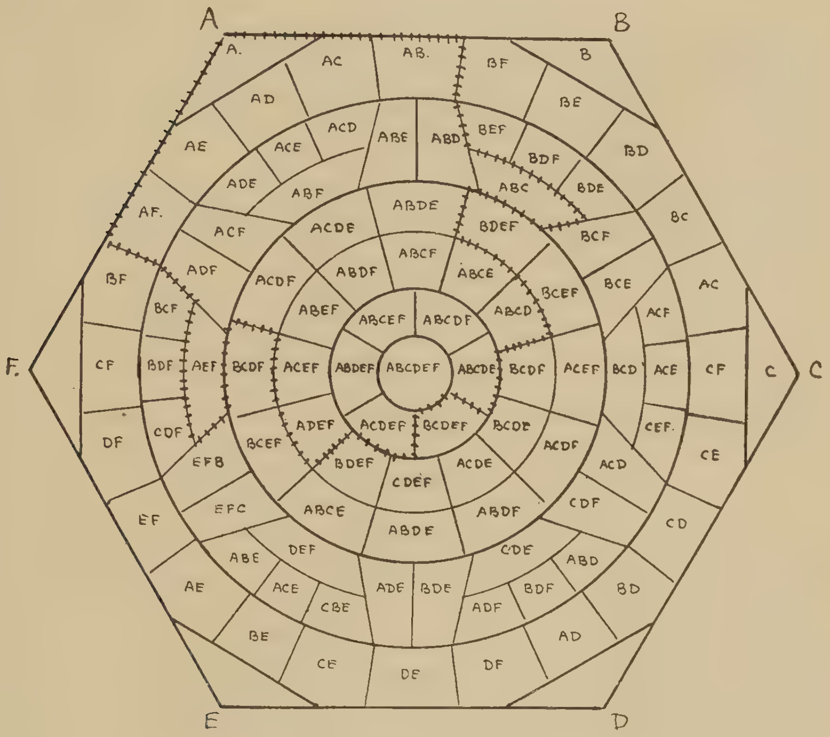
Fig. 4.



The method can of course be extended to more localities. For x localities there are 2^x-1 groups and of these 2^{x-1} contain any one of the localities. For example, with five localities there are 31 groups of which 16 contain the locality A. In six localities there are 63 groups of which 32 contain the locality A.

Both the analyses and the diagrams, however, become so complicated that it is doubtful if simplification, which is the object of the diagrams, can be achieved. For interest I have designed fig. 5 which shows a possible analysis of the relation of five localities. To get this diagram in two dimensions it was necessary to duplicate half of the groups with two localities and half of the groups with three localities. It will be seen that the number of localities varies from five in the centre to two in the outer ring and one in the corners of the pentagon. I have no available data to construct an actual frequency diagram to fit this.

FIG. 5.



Five or more localities.

Fig. 6 shows a similar diagram to cover the inter-relations of six localities, all the 32 containing the locality A being enclosed in the cross hatched line.

THE LOGARITHMIC SERIES AND THE COMPARISON OF ISLAND FLORAS.

By C. B. Williams, Sc.D.
(Rothamsted Experimental Station, Harpenden).

It has been shown recently that in random samples from mixed populations of animals or plants the number of species represented by one, two, three or more individuals fall into a mathematical order which is very closely represented by the logarithmic series

$$n_1 ; \ \frac{n_1x}{2} ; \ \frac{n_1x^2}{3} ; \ \frac{n_1x^3}{4} ;$$

where n_1 is the number of species with one individual and x is a constant (for the sample) less than unity. [See Fisher, Corbet and Williams, 1943.]

Fisher has also shown that, when this series holds, the ratio $\frac{n_1}{x}$ is a constant for all random samples from the same population, and we have called this ratio 'α' or the Index of Diversity.

It follows from the properties of the logarithmic series that if N is the number of individuals and S the number of species represented in any sample then

$$S = \alpha \log_e \left(1 + \frac{N}{\alpha}\right) \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (1)$$

or if N is large compared with 'α', as in most large samples, the '1' can be neglected in comparison with $\frac{N}{\alpha}$ and so

$$S = \alpha \log_e \frac{N}{\alpha} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (2)$$

In a previous publication (Williams, 1944) I have dealt very briefly with the possibility of using some of the properties of the logarithmic series in a study of the relationship of different populations such as the faunas or floras of islands or of any separate areas.

If we have two areas of land then, according to their ecological, geographical evolutionary relationships there will be more or fewer species common to the two. If they are close together and similar ecologically there will be many species in common, but, of course, owing to accidents of 'sampling' there may always be some in each that do not occur in the other, even if one area is considerably smaller than the other. If, on the contrary, the areas are far apart then there may be few or no species in common.

The logarithmic series gives us the possibility of calculating—with certain assumptions—the number of species that would be common to the two areas if they were merely random samples of the same populations, only differing in size. The assumption necessary is that the average density of the population is the same in both areas, or, in other words, that the number of individuals (but not species) is proportional to the areas under consideration. Also it is necessary that the areas shall be of different sizes.

The mathematical treatment is as follows :—

If there are two localities with areas A and B and with a and b species respectively in the group of plants or animals concerned. Then if the two populations were random samples of the same populations the value of the index of diversity 'α' would be the same for each sample and for the two combined.

Let T be the total number of different species in the two areas together on the assumption of identity; then * :—

(1) The increase in number of species by adding area B to area A

$$= T - a = \alpha \log_e \frac{A + B}{A}.$$

(2) The increase in number of species by adding area A to area B

$$= T - b = \alpha \log_e \frac{A + B}{B}.$$

From these two simultaneous equations T and α can be calculated if we know A, B and a and b.

The number of species common to the two areas on the assumption of identity of origin would therefore be

$$a + b - T.$$

If we know the actual number common to both, the ratio of this observed number to the calculated will be a measure of how closely the floras approach the assumed identity of origin.

In the original statement of this theory (*l. c.* pp. 42–43) the two Channel Islands of Guernsey and Alderney were taken as an example.

Guernsey is 24 square miles with 804 species of flowering plants.

Alderney is 3 square miles with 519 species. According to Marquand's 'Flora of Guernsey' (1901) there are 480 species common to the two islands.

On the assumption of identity of origin of the floras we get

$$T - 804 = \alpha \log_e 1{\cdot}125$$

$$T - 519 = \alpha \log_e 9{\cdot}00.$$

Hence T=820 and the number common to the two islands would be 503.

The ratio of 480/503=95·4 per cent. indicates that there is a close resemblance between the real relationship of the floras and the assumed identity.

Since 'α' is about 136 and the number of individual plants is certainly many millions, the mathematical assumption to neglect '1' in relation to N/α is obviously justified.

TABLE I.

Name of island.	Area in sq. kilom.	No. of species.	Found also on Principe,	Annobon,	Fernando Po.	Species excluding endemics.
São Tomé	1,000	556	183	80	187	448
Principe	126	276	—	52	128	241
Annobon	16	115	—	—	47	98
Fernando Po .	2,000	826	—	—	—	729

Recently A. W. Exell (1944) has published a full account of the Flora (vascular plants) of the island of São Tomé (San Thomé) off the west coast of Africa, in which he has included detailed comparisons of the flora with that of two other islands Annobon and Principe, and a less detailed comparison with the larger island of Fernando Po.

The data given are summarized in Table I. The four islands are roughly in a straight line. Fernando Po is about 32 kilometres from the mainland of the Cameroons; Principe is about 210 km. from Fernando Po; São Tomé is 135 km. from Principe; and Annobon about 180 km. from São Tomé. Annobon is 340 km. from the nearest coast (Cape Lopez, Gaboon).

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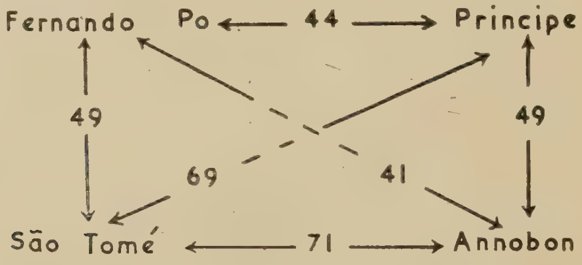
* In the original statement of this (Williams, 1944, pp. 42–43) a number of misprints unfortunately escaped notice owing to my absence abroad. These have been corrected above.

Calculations made from these figures by the method shown above give the percentage relationship of the observed number of species common to two islands, to that calculated on the assumption of identity of origin as follows :—

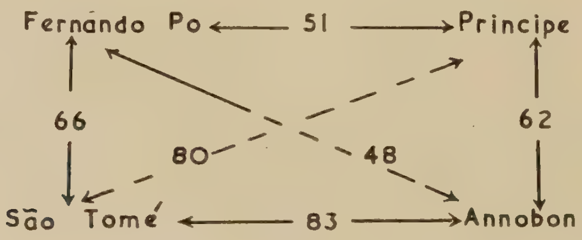


The closest relations are between São Tomé and Annobon (71) and São Tomé and Principe (69). The lowest between Annobon and Fernando Po (41). Fernando Po is more closely related to São Tomé than to Principe.

In a discussion with me, Mr. Exell suggested that it might be interesting to remove from the floras certain elements that might be considered botanically as interfering with the mathematical argument. These were : (1) a small number of species that were endemic to each island and must be supposed to have originated there and not to have been obtained from any wider population ; and (2) a number of widespread tropical weeds, whose presence in the different islands is largely due to commerce and whose recorded presence on the different islands is largely a matter of accident.

It is, of course, obvious that the removal of endemic species found in nearly every case only on single islands reduces the total number of species for each island without affecting the numbers common to two islands, and hence increases the calculated relationship. The removal of widespread common weeds, however, reduces both the total numbers of species and the number of species common to the two islands.

The last column in Table I. shows the new figures for the four islands with the endemic species removed, and the calculated relationships from this are as follows :—



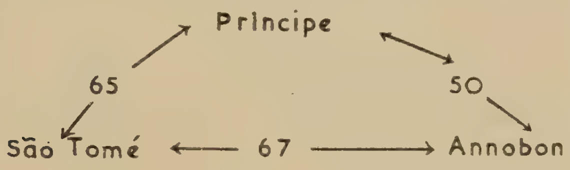
All the values are increased by an average of about 11 per cent. but the order remains the same. The largest increase is in the relation between San Tomé and Fernando Po.

Table II. shows the revised data when world-wide weeds are removed and when both these and endemics are removed. Data on these lines are not available at present from Fernando Po.

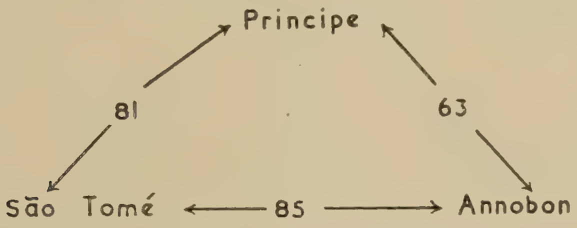
TABLE II.

	Excluding world-wide weeds.			Excluding both weeds and endemics.
	Species.	Found also on Principe,	Annobon.	
São Tomé	454	137	55	346
Principe	223	—	35	118
Annobon	83	—	—	66

This calculated relationships without the world-wide weeds is :—



and without both weeds and endemics is :—



In the first case the relation between São Tomé and the other two islands is slightly reduced, but not to the extent that might have been expected. That between Principe and Annobon remains practically unchanged.

In the second case the values are all very slightly above those obtained with the endemics only removed.

These results have been obtained from the data by mathematical processes only and have not taken into account the identity of the species that are common or to what families they belong. It is important, therefore, to see how the conclusions fit in with the considered opinion of a botanist who knows both the plants and the islands under consideration. For this purpose I have asked Dr. Exell to add his comments, which are given below.

It is also of interest to the general problem to know whether under any circumstances the observed numbers of species common to two areas could be larger than that calculated on the assumption of identity of origin. I find that this can happen and that there is a simple explanation of it. For example, in Great Britain there are approximately 792 species of Macrolepidoptera (butterflies and the larger moths). Ireland has approximately 550 species in the same group, but their list does not include a single species which is not also found in Great Britain. The addition, therefore, of the 32,000 square miles of Ireland to the 89,000 square miles of Great Britain does not add a single species to the list.

All the 550 species in Ireland are common to both areas, whereas calculation on the assumption of identity of origin gives only 477; the observed number is 115 per cent. of the calculated.

The explanation must be that the two faunas cannot be looked upon as independent random samples of a greater European fauna, but the Irish fauna has largely been derived from that of Great Britain. With the exception of those species which have reached both countries independently from the south, the species have had to pass through England to reach Ireland.

Thus a percentage relation of over 100 per cent. would be an indication that the smaller of the populations had been derived from the larger.

It is, of course, always possible that both processes may have taken place simultaneously, in which case the interpretation of purely mathematical results would be difficult. It is not, however, claimed that the method is either absolute or could replace other forms of evidence. All methods must be used to get the best possible conclusion, and the mathematical technique appears to be a new possibility to add to those already in existence.

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DISCUSSION OF THE PERCENTAGE RELATIONSHIP CALCULATED BY DR. WILLIAMS.

By A. W. EXELL, M.A., F.L.S.

In discussing the affinities of the floras of the islands of the Gulf of Guinea (*Cat. Vasc. Pl. of São Tomé,* 1944, p. 48, *et seq.*), I pointed out the difficulties met with in attempting to arrive at a mathematical formula to express relationship between floras of different sizes. I was therefore greatly interested when Dr. Williams told me of the important paper by Fisher, Corbet and himself to which he has referred and which was published before the Catalogue, though some years after my remarks were written. The war prevented my knowing of it in time to see that my difficulties had been resolved. This paper and further work by Dr. Williams seem to provide the exact method for which I searched in vain and I am convinced that it is a valid one. My task now is to comment on the results.

In the final set of figures worked out by Dr. Williams for Principe, São Tomé and Annobon, those obtained by excluding endemics and widespread tropical weeds, we have to explain why the percentage relationships (from 63 to 85 per cent.) fall so far below the theoretical 100 per cent. expected from common origin which is so nearly approached (95 per cent.) in the case of Guernsey and Alderney (Williams, 1944). There can be little doubt that the floras of Principe, São Tomé and Annobon are derived from the neighbouring continent of Africa, as those of Guernsey and Alderney are derived from the continent of Europe. The probable reasons for the discrepancy are :—

(*a*) In the case of the Channel Islands the floras are presumably very fully investigated and almost all the species known and identified, while the floras of the Guinea Islands are still imperfectly known with further discoveries still to make.

(*b*) The Channel Islands are ecologically similar to the neighbouring coastal area of the north of France: the Guinea Islands are volcanic and extremely mountainous while most of the neighbouring African territory is comparatively low-lying with the exception of the Cameroons Mountain massif.

(*c*) The floras of the Channel Islands were derived from a relatively homogeneous flora : the Guinea Islands are rather small samples from a flora which is certainly not homogeneous around the whole wide sweep of the Gulf of Guinea so that the ' common origin ' of their floras has to be taken in a rather broader sense than for the Channel Islands.

(*d*) The Channel Islands species are mainly herbaceous and most of them have probably survived cultivation ; while the flora of the Guinea Islands is largely arboreal and composed mainly of forest species of which a great many were certainly destroyed when the forest in the lower parts of the islands was cut down in the process of making plantations. The lower zone consisted largely of different species from those of the upper zone, where virgin forest still survives. Most of the collecting was done after the destruction of the forest in the lower zone was nearly complete and many species undoubtedly escaped record.

All these factors affect the results. Whether the percentage relationships for Principe, São Tomé and Annobon are relatively high or not, bearing in mind the factors mentioned, can only be decided when we have results available for other tropical islands similarly placed in relation to a continental mass.

Next, we may consider the percentage relationships between the four islands (including Fernando Po) taking the data for all recorded species (first diagram). It would have been better to exclude the tropical weeds, but owing to difficulties due to the war I have not been able to produce the figures for Fernando Po, of which no separate list of species exists. The effect of removing the weeds is not very great. With the inclusion of endemics we are using Dr. Williams's method as a convenient way (probably the only convenient way) of making a straightforward comparison of floras of different sizes. Now that we can estimate how many species two samples varying considerably in size should theoretically have in common, given supposed common origin, the comparison can be made without difficulty and a much clearer picture can be given than the one I tried to present in the Catalogue.

The four islands, Fernando Po, Principe, São Tomé, and Annobon recede from the continent of Africa in that order. Dr. Williams's figures eliminate all difficulties due to the different sizes of the islands, but there remains the important factor of altitude. Fernando Po reaches 2,850 m., Principe 948 m. (but only collected up to 680 m.), São Tomé 2,024 m. and Annobon 655 m. Fernando Po has an element of temperate affinity also very slightly represented in São Tomé but absent from the two smaller islands. There are also a considerable number of species occurring at high altitudes in Fernando Po and São Tomé which, although not of temperate affinity, are not to be found in Principe and Annobon because their altitudes are insufficient.

The highest percentage relationship, 83 per cent. between São Tomé and Annobon, seems to be according to expectation and to be due entirely to proximity. Annobon is furthest from the coast and it may be reasonably supposed that its flora was partly derived from the relatively large adjacent island of São Tomé.

Principe is 210 km. from Fernando Po and 135 km. from São Tomé. It has an 80 per cent. relationship with São Tomé and a 15 per cent. relationship with Fernando Po. This difference seems reasonably explicable by closer proximity to the former and (as weeds are included in these figures) much greater commercial intercourse with São Tomé. A further reason may be that much collecting on Principe and São Tomé was done by people with little scientific training who took everything, while Fernando Po was mainly collected by professional botanists who probably did not trouble much about common tropical weeds.

Fernando Po has a 66 per cent. relationship with São Tomé and only 51 per cent. with Principe although the latter is much nearer, lying actually directly between the two larger islands. The reason for this would certainly be the higher altitude of Fernando Po and São Tomé giving a large number of common species which can find no place on Principe.

Fernando Po and Annobon, the greatest distance apart and with the greatest difference of altitude show, naturally, the smallest relationship.

Thirdly, in Dr. Williams's last sets of figures (without widespread weeds and without both weeds and endemics), the effect of intercourse between São Tomé and Principe, has been at least partly removed. This has slightly increased the São Tomé-Annobon relationship compared with the São Tomé-Principe relationship, as was to be expected.

The results obtained by Dr. Williams's statistical method agree admirably with the conclusions as to the relationships between the islands which I had already reached in my account of their affinities given in the Catalogue.

ON NEW AND RARE BRITISH SPIDERS.

By A. F. Millidge and G. H. Locket.

During recent years we have taken a few spiders new to Britain, and these are described in the present paper. We are taking this opportunity also of recording the occurrence during recent years of a number of rare spiders and additions to county records.

(i) *Spiders new to Britain.*

The following spiders new to Britain are described, viz. :—

Centromerus serratus Cambr. : both sexes ; species new to Britain.
Centromerus satyrus Sim. : both sexes ; species new to Britain.
Dismodicus elevatus C. Koch : female ; this *species* is not new to Britain, the male having been previously discovered and figured by A. R. Jackson (1915).

O. P. Cambridge (1907) recorded the capture of *C. serratus* Cambr. in Yorkshire. This was subsequently shown to be erroneous by the late Dr. A. R. Jackson (1916), the specimens being in fact *C. silvaticus* Bl. (female) and *C. prudens* Cambr. (male). A female Linyphiid spider taken by one of us (A. F. M.) in August 1941 near Carisbrooke, Isle of Wight, was identified by Jackson as the true *C. serratus* Cambr. No further specimens came to light from the original locality, but in the winter of 1943 two females were taken in Parkhurst Forest, Isle of Wight, and subsequently several males and females were taken in the latter locality, all in pine needles.

A female of *C. satyrus* Sim., identified by Jackson, was taken, probably in Middlesex or Buckinghamshire, in 1935 by one of us (G. H. L.). In October 1944 a male and female of this species were taken by us at Great Kimble, Bucks, in a beechwood, in the same locality which furnishes *Prosopotheca corniculans* Cambr., captured as a species new to the mainland of Britain in 1937 by the late Dr. A. R. Jackson and one of us (G. H. L.). (This *Prosopotheca* sp. had previously been found in the Channel Islands : W. S. Bristowe (1929).) The *Centromerus*, obtained with *P. corniculans* Cambr. by shaking the beech leaves over newspaper, occurred again in this locality in the autumn of 1945 (G. H. L. and Mr. A. A. D. LaTouche).

These two *Centromerus* species, unlike others of the genus, are armed with only one spine on the fourth tibiae. They are small pale-coloured spiders. The males of both species have a stout spine on the palpal patella, and the palpal organs are very similar. The females have epigynes of similar structure.

C. serratus Cambr. is so like *C. silvaticus* Bl. in the male and female genitalia, that it is difficult to escape the conclusion that it is a degenerate or primitive form of the latter, perhaps attaining its pale colour and small size from a troglodyte existence at some time, *e.g.*, possibly in the last ice age.

During his trip in 1914 to the Scottish Highlands the late Dr. A. R. Jackson (1915) captured a male of *Dismodicus elevatus* C. Koch. In August 1945, one of us (G. H. L.) paid a visit to this area, and amongst other spiders took a female *Erigonid* almost certainly of this species. Its identity cannot, unfortunately, be confirmed by comparison with authentic European specimens, as none are available in the British Museum (Natural History) at the present time. It is closely similar to *D. bifrons* Bl. female, but can be distinguished by its epigyne.

Brief descriptions are now given, with figures, for these species, as none are available in recent British literature.

CENTROMERUS SERRATUS Cambr.

Length : ♀=1·3–1·5 mm., ♂=1·3–1·5 mm.

The legs, palps, carapace and sternum are pale-yellow to yellow, and the abdomen, which is whitish to grey, is clothed with fine hairs. The sternum is also clothed with long fine hairs. The tibiae of legs I–III are armed with two short fine spines, one basal and one apical, not much longer than the diameter of the segment. The tibiae of legs IV have only one spine each—the basal one. The metatarsi of legs I and II are armed with one short spine, the remaining metatarsi are without spines. The metatarsi of legs I–III have a long trichobothrium near the base ; the metatarsi of legs IV have no trichobothrium. The female epigyne (fig. 1), which is very similar in general appearance to that of *C. silvaticus* Bl., has a tapering tongue of wrinkled appearance partially covering the opening, and is of very characteristic appearance, covering a large proportion of the area of the ventral side of the abdomen. The male palp (fig. 2) has the patella armed above with a stout forward-directed spine ; the tarsus is gibbous above basally, and has large, well-developed complex sexual organs, generally similar to those of other members of the genus *Centromerus*. The paracymbium is armed along the internal basal margin with a large number of fine teeth, highly chitinised ; this paracymbium is characteristic and serves to identify the species in the male.

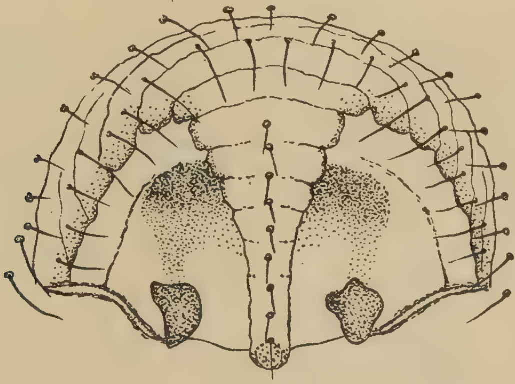

FIG. 1.—*Centromerus serratus* Cambr.

This spider, though similar in genitalia to *C. silvaticus* Bl., need not be confused with this, for the latter is a much larger spider, darker in colour, and the spinal armature of the legs is different.

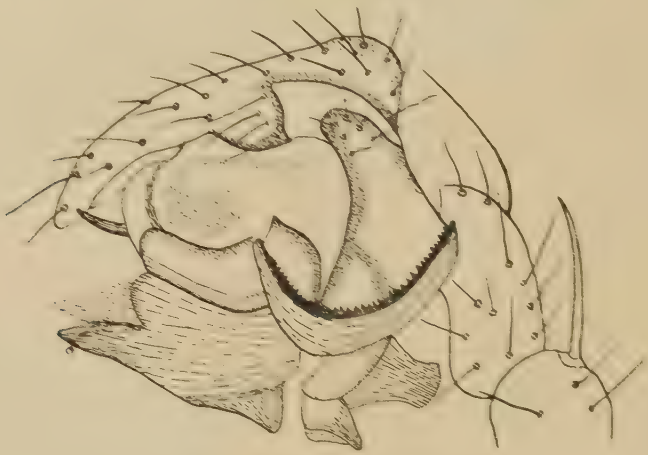

FIG. 2.—*Centromerus serratus* Combr.

CENTROMERUS SATYRUS Sim.

Length : ♀=1·5 mm., ♂=1·75 mm.

The legs, palps, carapace and sternum are pale-yellow, and the abdomen is pale whitish-grey clothed with fine hairs. The sternum is also clothed with long fine hairs. In the female, the tibiae of legs I and II are armed with two short fine spines, one basal and one apical, not much longer than the diameter of the segment, while the tibiae of legs III and IV have only one spine—the basal one. In the male, the tibiae of legs I–III are armed with the two short fine spines, while the tibiae of legs IV have only one spine each. The metatarsi of legs I and II are armed with one short spine, the remaining metatarsi are without spines. The metatarsi of legs I–III have a long trichobothrium near the base ; the metatarsi of legs IV have no trichobothrium. The female epigyne (fig. 3) is similar in pattern to that of *C. serratus* Cambr., but the ' tongue ' is much shorter and of different shape ; the epigyne covers a large

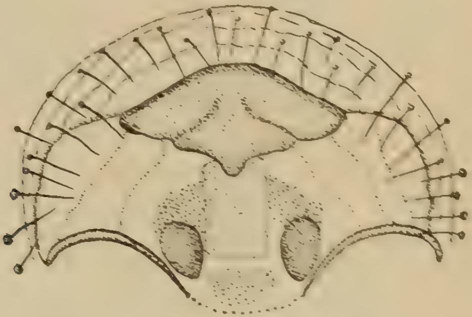

FIG. 3.—*Centromerus satyrus* Sim.

proportion of the ventral side of the abdomen. The male palp (fig. 4) is very similar to that of *C. serratus* Cambr.; the patella is armed with a stout forward-directed spine; the tarsus is gibbous above basally, and has large well-developed

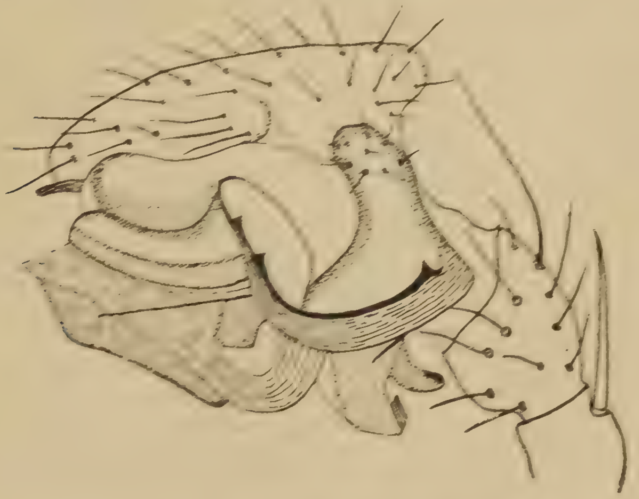

FIG. 4.—*Centromerus satyrus* Sim.

complex sexual organs. The internal basal margin of the paracymbium is armed with three dark teeth only; this paracymbium is characteristic and serves to identify the species in the male.

DISMODICUS ELEVATUS C. Koch.

Length: ♀=2·25 mm.

The general coloration and chætoxy are similar to *D. bifrons* Bl. The carapace is dark brown, shading to blackish brown on the caput, which is more elevated and globular than in *D. bifrons* Bl. The abdomen is dorsally greyish-

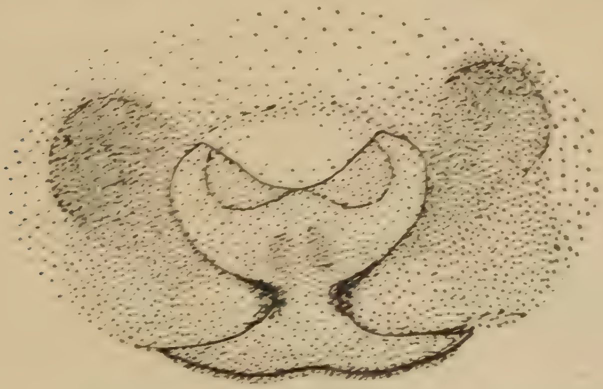

FIG. 5.—*Dismodicus elevatus* C. Koch.

black with a number of paler transverse angular bars towards the spinners. The sternum is brown with darker edges. The legs and palps are orange-brown. On the whole the present specimen is rather darker or richer in colour than *D. bifrons* Bl. The female epigyne (fig. 5) has the central part or 'fovea' shaped like a cup on a stalk, or a flat wine-glass. Jackson (Proc. Zool. Soc. Lond., B, 107 (1937), p. 550), gives good descriptions but no figures of the epigynes of the four known species of *Dismodicus*. Although the epigyne of *D. elevatus* C. Koch is similar in general design to that of *D. bifrons* Bl., it differs considerably in detail from the latter species, which is also figured for comparison (fig. 6).

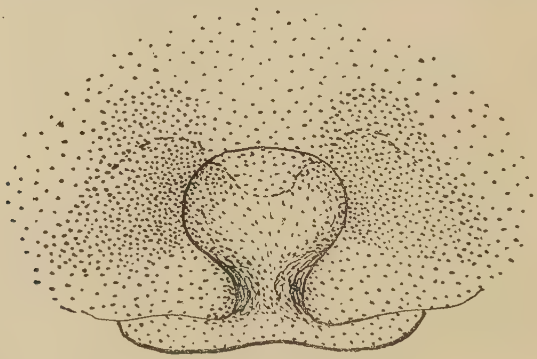

FIG. 6.—*Dismodicus bifrons* Bl.

(ii) *Occurrence of Some Rare Spiders and Additions to County Records.*

We have captured a number of rare spiders during the past few years, and obtained some additions to the county records subsequent to those recorded in Dr. W. S. Bristowe's book 'The Comity of Spiders', vols. I. and II. These are now put on record.

Species new to the County lists are marked with an asterisk (*).

Dictyna pusilla Westr. Immature specimens (subsequently reared) were abundant in Abernethy Forest, September, 1945.

**D. puella* Sim. Both sexes at Shirrenden Lake, *Kent*, August, 1945.

**Oonops domesticus* de Dalm. *Leicester*, April, 1941 (sent by Miss P. C. Gardiner); *Lancs.* March, 1944; the latter record is the farthest north this species has been reported in Britain—it was taken as usual inside a dwelling house.

**Scytodes thoracica* Latr. An immature specimen in a dwelling house at Newport, *Isle of Wight.*

**Physocyclus simoni* Berl. Both sexes were abundant in dry wine cellars, its usual haunt, in June, 1944, at Harrow, *Middlesex*; Dr. W. S. Bristowe showed us where to find this species.

**Drassodes silvestris* Bl. A female in woods at Horsmonden, *Kent*, April, 1939.

Zelotes pedestris C. L. Koch. A gynandrous specimen was taken in Isle of Wight in May, 1940.

Gnaphosa leporina L. Koch. A female of this uncommon species was taken in Abernethy Forest, September, 1945.

Micaria alpina L. Koch. Adult males of this mountain species occurred on Glyder Fawr in June, 1942; no females were taken.

**Clubiona diversa* Cambr. Ruislip, *Middlesex*; taken by Mr. W. H. Barrett in May, 1945. A male at Loch Garten, *Inverness*, September, 1945.

**C. subsultans* Thor. A male at Nethy Bridge, *Inverness*, September, 1945; previously taken by Jackson (1914) in Black Wood of Rannoch.

**Agroeca proxima* Cambr. *Inverness*, September, 1945.

*_Liocranum rupicola_ Walck. Near Denham, _Bucks_, September, 1944.

Phrurolithus minimus C. L. Koch. This rare species still occurs quite frequently in two woods in the Isle of Wight.

*_Zora spinimana_ Sund. This common species was taken in _Inverness_ during September, 1945.

Z. nemoralis Bl. This rare species also occurred in Inverness (Abernethy Forest) at the same time as the last.

*_Xysticus ulmi_ Hahn. Taken in _Inverness_, September, 1945.

*_X. luctuosus_ Bl. Beaten from furze in Parkhurst Forest, _Isle of Wight_, in June, 1944.

*_Oxyptila simplex_ Cambr. Both sexes on sand dunes at Yarmouth, _Isle of Wight_, in May, 1940.

*_Bianor aenescens_ Sim. This rare spider was found amongst coarse grass in Parkhurst Forest, _Isle of Wight_, in May, 1940.

Myrmarachne formicaria de G. This very rare ant-like Salticid occurred quite commonly on a cliff ledge near Shanklin, Isle of Wight, in June, 1939.

*_Arctosa perita_ Latr. A male of this sand-loving spider was taken at Harrow, _Middlesex_; the species also occurred in _Warwick_ in the summer of 1945.

*_Amaurobius atropos_ Walck. This species was found under stones at Edge Hill, _Warwick_, in June, 1945.

*_Hahnia helveola_ Sim. This spider was found in dead leaves, etc. in woods in _Isle of Wight_.

*_H. pusilla_ L. Koch. This rare species was found amongst grass, etc. on the banks of the Mersey estuary at Hale beach, _Lancs._, where it occurs adult in spring and autumn.

*_Tetragnatha nigrita_ Lendl. Horsmonden, _Kent_; and Ruislip, _Middlesex_.

*_Eugnatha striata_ L. Koch. This species, which seems to be found only on reeds and rushes in standing water, occurred in this situation in Shirrenden Lake, Horsmonden, _Kent_, in April, 1939, and August, 1945.

*_Cercidia prominens_ Westr. This spider occurred on its little orb-web placed just above ground level in a wood in _Isle of Wight_, in May, 1940, and also on sand dunes in the same area.

*_Aranea triguttata_ Fabr. Ruislip, _Middlesex_, May, 1945; _Inverness_, September, 1945.

*_A. undata_ Oliv. _Oxford_, in June, 1939 and 1945.

*_Zygiella litterata_ Oliv. _Inverness_, September, 1945.

*_Theridion lunatum_ Oliv. Ruislip, _Middlesex_, May, 1945 (Mr. W. H. Barrett).

*_T. instabile_ Cambr. A female in a marsh near Carisbrooke, _Isle of Wight_, in May, 1940.

Dipoena tristis Hahn. This rare spider occurs quite frequently in places in Parkhurst Forest, Isle of Wight, in May–June; it is obtained by beating the bushes, and seems to live on the large wood ant (_Formica rufa_ Linn.).

*_Ero cambridgei_ Kulcz. _Inverness_, September, 1945.

*_Ceratinella brevis_ Wid. In undergrowth of woods near Kenilworth, _Warwick_, autumn, 1945.

*_Blaniargus herbigradus_ Bl. Common in undergrowth in woods, _Warwick_.

*_Nothocyba subaequalis_ Westr. Both sexes in a garden at Coventry, _Warwick_; summer, 1945; female at grass roots in Parkhurst Forest, _Isle of Wight_, December, 1944.

*_Anacotyle stativa_ Sim. A female at Horsmonden, _Kent_, August, 1945. in grass (G. H. L. and Mr, A. A. D. La Touche).

*_Moebelia penicillatus_ Westr. On tree trunks, _Isle of Wight_.

*_Panamomops sulcifrons_ Wid. A female in straw near a farm, _Warwick_, October, 1945.

**Lophocarenum parallelum* Wid. Both sexes under sods in a field near Baginton, *Warwick*, August, 1945 ; Harrow, *Middlesex*, 1938.

**L. nemorale* Bl. Sand dunes, and undergrowth of woods, *Isle of Wight*, autumn and winter.

**Trichopterna mengei* Sim. *Inverness*, September, 1945. A rare species, except in a few localities.

Hybocoptus decollatus Sim. This species still occurs in its only British locality, on bushes round the coast of the Isle of Wight.

**Minyriolus pusillus* Wid. Both sexes common in pine needles in Parkhurst Forest, *Isle of Wight*, in autumn.

Caledonia evansi Cambr. This northern species was taken in Abernethy Forest in September, 1945.

**Nematogmus obscurus* Bl. A male at Borthwood, *Isle of Wight*, in May, 1940 ; this is a common species in the north of England.

**Silometopus interjectus* Cambr. Both sexes in straw near a farm in *Warwick*, autumn, 1945.

Mecopisthes pusillus Menge. This very rare species still occurs sparingly on the sandhills around Southport, Lancs.

**Pocadicnemis pumila* Bl. This common species has now been found in *Warwick* (1945).

**Tiso vagans* Bl. This widely distributed spider occurs in *Warwick*.

T. aestivus L. Koch. This mountain species still occurs under stones on the summit of Glyder Fawr, Carnarvon (June, 1943).

**Diplocephalus picinus* Bl. *Inverness*, September, 1945.

**Areoncus humilis* Bl. *Warwick* ; *Kent* ; a common spider at times.

**A. hiemalis* Bl. *Carnarvon*, September, 1940 ; *Inverness*, September, 1945.

**A. ignobilis* Cambr. This rare species is found in a marshy spot near Carisbrooke, *Isle of Wight*, in spring and autumn.

**Monocephalus fuscipes* Bl. This is an exceedingly common species in the undergrowth of woods ; *Warwick* ; *Inverness*.

**Typhocrestus digitatus* Cambr. A female on sand dunes at Yarmouth, *Isle of Wight*, December, 1943.

**Troxochrus scabriculus* Westr. Taken with the last species, *Isle of Wight* ; in straw, and in woods, *Warwick*.

**Aulacocyba subitanea* Cambr. In straw near a farm, *Warwick*, autumn, 1945.

**Colobocyba insecta* L. Koch. In Crackley Woods, near Kenilworth, *Warwick*, autumn, 1945 ; an uncommon species.

**Wideria cucullata* C. L. Koch. This species, which occurs amongst dead leaves, etc., in woods, has turned up in *Isle of Wight* and *Warwick*, in autumn.

**W. fugax* Cambr. Both sexes of this handsome little spider were taken in pine needles in Parkhurst Forest, *Isle of Wight*, in January, 1944 ; it is very uncommon.

W. capito Westr. The female of this species is still plentiful on the summit of Glyder Fawr (June, 1943) ; the male has not turned up yet.

**Walckenaera acuminata* Bl. In the undergrowth of woods, *Warwick*.

**Trachynella nudipalpis* Westr. *Isle of Wight*.

T. obtusa Bl. A male of this very rare species was taken at Horsmonden, Kent, in April, 1939.

Evansia merens Cambr. This myrmecophilous spider was taken in Abernethy Forest, Inverness, September, 1945.

**Prosopotheca monoceros* Wid. On sand dunes, *Isle of Wight* ; and in Abernethy Forest (not new to Inverness).

P. corniculans Cambr. This species still occurs quite freely in its original and only locality on the British mainland, viz., a beechwood at Great Kimble, Bucks.

**Tigellinus furcillatus* Menge. At the roots of heather (its usual habitat) at Hurt Wood, *Surrey*, June, 1939.

**Cornicularia cuspidata* Bl. Both sexes in a pine copse, *Isle of Wight*, autumn, 1944.

Dismodicus elevatus C. L. Koch. Female new to Britain. See above.

Erigone tirolensis L. Koch. A male was taken on Cairn Gorm at 4,000 feet in September, 1945.

**Gongylidiellum vivum* Cambr. In a marshy area near Carisbrooke, *Isle of Wight*, May, 1940 ; both sexes.

**Asthenargus paganus* Sim. This rare species was taken freely in moss in a wood near Capel Curig, *Carnarvon*, in May, 1944 ; it was also found not infrequently in grass roots, moss, etc., at Crackley Woods, near Kenilworth, *Warwick*, autumn, 1945.

Donacochara speciosa Thor. This rare species still occurs on rushes at Shirrenden Lake, Horsmonden, Kent ; both sexes, just coming to maturity, were taken in August, 1945 (G. H. L. and Mr. A. A. D. LaTouche).

Coryphaeolanus holmgreni Thor. A female of this northern mountain species occurred on Cairngorm at 4,000 ft., in Sept. 1945. Previously recorded by Jackson (1914)

**Scotargus inerrans* Camb. This uncommon species was taken in the *Isle of Wight*, females in a marshy area, and a male on sand dunes, in June. Very surprisingly, also, from a swift's crop.

**Mioxena blanda* Sim. Amongst marram grass on sand dunes near Birkdale, *Lancs.*, in Sept. 1940 ; a rare species.

**Ostearius melanopygius* Cambr. This striking spider, with its black and red abdomen, occurred freely on sand dunes at Yarmouth, *Isle of Wight*, in Sept. 1945.

**Peponocranium ludicrum* Cambr. Adults in May, 1944 : base of Glyder Fawr, *Carnarvon.*

**Maso sundevalli* Westr. This common species has turned up in *Warwick.*

**Phaulothrix hardyi* Bl. *Inverness*, September, 1945.

**Maro minutus* Cambr. This rare species was taken freely in moss in a wood near Capel Curig, *Carnarvon*, May, 1944.

**Porrhomma montanum* Jacks. Delamere Forest, *Cheshire* ; almost at sea level ! June, 1943.

**P. pallidum* Jacks. *Inverness* : September, 1945.

**Taranucnus setosus* Cambr. *Isle of Wight* ; a male.

**Tapinopa longidens* Wid. Not uncommon in woods, particularly at the base of trees ; *Isle of Wight* ; *Warwick.*

**Floronia frenata* Wid. Shirrenden Lake, Horsmonden, *Kent*, August, 1945.

Leptyphantes expunctus Cambr. Locally abundant, Abernethy Forest, September, 1945.

**L. mengei* Kulcz. Parkhurst Forest, *Isle of Wight.*

**Centromerus arcanus* Cambr. Both sexes in dead leaves in a wood near Capel Curig, *Carnarvon*, May, 1944.

**C. silvaticus* Bl. Parkhurst Forest, *Isle of Wight*, September, 1944.

**C. serratus* Cambr. New to Britain ; see above. *Isle of Wight.*

**C. satyrus* Sim. New to Britain ; see above. *Buckinghamshire.*

C. laevitarsis Sim. This species still occurs in its only British locality at Oakmere, Cheshire.

**Oreonetides abnormis* Bl. A female at Great Kimble, *Bucks*, October, 1945.

**Syedrula innotabilis* Cambr. On the bark of trees, *Isle of Wight.*

**Meioneta saxatilis* Bl. Parkhurst Forest, *Isle of Wight.*

M. gulosa L. Koch. This species is still common on the Welsh mountains, and one was taken on the railway station at Bettws-y-Coed.

We would like to take this opportunity of putting on record our indebtedness and gratitude to the late Dr. A. R. Jackson for his constant help and kindliness; to the authorities of the British Museum (Natural History) for the facilities and courtesy granted us for studying the specimens in their collections; and to Dr. W. S. Bristowe for his continued advice and encouragement.

References.

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PROCEEDINGS OF THE ANNIVERSARY MEETING
24 May 1946

Mr. A. D. Cotton, O.B.E., President.
in the Chair.

The Proceedings of the General Meeting held on Thursday, 9 May 1946, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—The Trustees of the Transvaal Museum, Pretoria, Capt. Eric Hardy, Prof. B. A. Fedtschenko, Prof. J. Puyo, The British Council and Dr. W. E. Collinge.

The following Fellows signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Edgar Milne-Redhead, Dr. Debabrata Chatterjee and Dr. Nicholas Polunin.

The President referred to the presence of Mr. H. N. Ridley, C.M.G., F.R.S., the oldest member of the Society. Mr. Ridley replied.

Candidates for membership were balloted for and elected :—

As Fellows :—Gerald Mortimer Ash, Sir Nigel Gresley Ball, Bt., M.A., Sc.D., Rear-Admiral Tufton Percy Hamilton Beamish, C.B., G. D. Bhavnani, M.Sc., Winifred M. A. Brooke, Robert Brown; D.Sc., Laurence Chalk, Earle Leslie Davison, Douglas Dawson, William Ernest Dick, B.Sc., Alan Robertson Gemmell, B.Sc., Ph.D. (Glasg.), M.S. (Univ. Minnesota), Prof. T. H. Goodspeed, Ph.D., Frederick Cyril Grigg, Sydney Cross Harland, D.Sc. (Lond.), F.R.S., Daniel Darius Haynes, Idris Valentine Hunt, M.Sc., Harold Augustus Hyde, M.A., Chester Jones, B.Sc., Ph.D., Frank Whitwam Jones, M.A. (Cantab.), Norman Sumner Jones, M.Sc., Major Maxwell Knight, O.B.E., Major Oscar Martin Lee, R.A.S.C., Margaret Alice Palmer Madge, B.Sc., Ph.D., William Marshall, B.Sc. (Edinb.), Harold Philip Moon, M.A. (Cantab.), Herbert Francis Mooney, O.B.E., E.D., M.A., Sc.D. (Dublin), Frank Robert Mumford, B.Sc., John Dean Palmer, Colonel Robert Bernard Phayre, M.C., John Leslie Rees, Miss Catherine Muriel Rob, Promode Kumar Sanyal, B.Sc., Ph.C., Brigadier Henry Gilbertson Smith, C.B., O.B.E., M.C., T.D., Herbert Stone, Herbert George Stubbings, M.A., Ph.D. (Cantab.), B.Sc. (Lond.), Major Patrick Millington Synge, F./Lieut. Roland Mark Underhill, B.Sc., David Henriques Valentine, M.A., Ph.D., Errol Ivor White, D.Sc., Ph.D., Sydney Renoden Wycherley.

As FOREIGN MEMBERS :—Professor Jan Bělehrádek, Rector of Prague University ; Prof. H. Boschma, Director, Natural History Museum, Leiden ; Dr. Josias Braun-Blanquet, Director, International Station of Geobotany, Montpelier ; Prof. Edouard Chatton, Director, Marine Laboratories, Banyuls-sur-Mer (Pyr. Orient) ; Dr. François Gagnepain ; Prof. Johan Hjort, President, International Council for the Exploration of the Sea ; Dr. N. A. Maximov, Director, Institute of Plant Physiology, Moscow ; Knud Hensch Stephensen, M.Sc., Zoological Museum, University, Copenhagen ; Dr. Victor van Straelen, Director, Natural History Museum, Bruxelles ; Prof. Johanna Westerdijk, Centraalbureau voor Schimmelcultures, Baarn, Netherlands.

As an ASSOCIATE *honoris causa* :—Frederick James Pittock.

As an ORDINARY ASSOCIATE :— Mrs. Hilda Mabel Canter, B.Sc.

The Bye-Laws regulating the Election of Council and Officers having been read by the Assistant Secretary, the PRESIDENT declared the Ballot for new Members of Council to be open, and voting began. The PRESIDENT thereafter appointed Capt. B. L. BURTT, Dr. C. R. METCALFE and Dr. A T. HOPWOOD as Scutineers of the Ballot.

The Ballot was closed at the due time, and the result declared to the Meeting,—NEW MEMBERS OF COUNCIL.—Prof. G. R. de Beer, F.R.S., Dr. R. Dennell, Dr. A. T. Hopwood, Mr. H. W. Parker, Dr. W. B. Turrill.

(The retiring Councillors were Capt. C. Diver, C.B.E., Dr. F. C. Fraser, Mr. C. C. Hentschel, Dr. N. A. Mackintosh and Dr. R. Melville.)

The PRESIDENT declared the Ballot for Officers to be open and voting began. The Ballot was closed at the due time, and the result declared to the Meeting,—OFFICERS.—*President* : Professor G. R. DE BEER, F.R.S. ; *Treasurer* : Colonel F. C. Stern, O.B.E., M.C. ; *Botanical Secretary* : Dr. B. Barnes ; *Zoological Secretary* : Dr. Malcolm A. Smith.

The Financial Report was given by the Treasurer and the Accounts of the Society, duly audited, for the year 1945–46 were laid before the meeting.

On a motion by Dr. EDWARD HINDLE, F.R.S., seconded by Prof. A. J. E. CAVE, the Report and Statement of Accounts were adopted.

TREASURER'S ACCOUNTS FOR THE

(Presented at the Anniversary

Receipts and Payments of the Linnean Society

General

RECEIPTS	£	s.	d.	£	s.	d.
To Balance at 1 May 1945 :—						
Current Account at Bank	281	11	10			
Deposit Account Post Office Savings Bank	940	10	3			
Cash in hand	7	14	0			
				1229	16	1
„ Admission Fees				60	0	0
„ Arrears of Annual Contributions	69	0	0			
„ Annual Contributions for year	1913	13	0			
Do. in advance	55	8	0			
				2038	1	0
„ Do. of Associates				11	0	0
„ Composition Fees				164	0	0
„ Interest on Investments (including Income Tax recovered)				311	16	1
Do. Post Office Savings Bank Account				101	8	4
„ Sales of Publications :—						
Transactions	22	6	9			
Journals	57	18	11			
Proceedings	20	10	1			
				100	15	9
„ Grants and donations in aid of Publications				850	0	0
„ Miscellaneous Receipts				7	19	11
„ Deposits by candidates awaiting election				12	0	0
				£4886	17	2

Library

RECEIPTS	£	s.	d.
To Balance 1 May 1945	214	4	1
„ Interest on Investments (including Income Tax recovered)	50	15	6
„ Deposit Account Interest		7	0
„ Donations	15	10	0
„ Transfer from General Account	100	0	0
	£380	16	7

Fellows' Postal

RECEIPTS	£	s.	d.
To Balance at 1 May 1945	50	0	11
	£50	0	11

YEAR ENDED 30 APRIL 1946

Meeting, 24 May 1946)

from 1 *May* 1945 *to* 30 *April* 1946.

Account

PAYMENTS	£	s.	d.	£	s.	d.
By Coal, Electric Current, and Gas				90	4	9
,, Repairs: Sundry				152	17	0
,, Taxes and Insurance				56	3	10
,, Miscellaneous Printing and Stationery				95	6	0
,, Petty Expenses and Postages				156	10	7
,, Fire Watching Expenses and A.R.P.				5	1	1
,, Publications :—						
Printing	286	6	7			
Illustrations	6	10	3			
Distribution	14	7	6			
* Not including approximately £1400 for Printing in hand.				*307	4	4
,, Salaries, Wages, etc.				1073	2	8
,, 'Zoological Record' Vol. 81) Donation				15	0	0
,, Biological Council—Donation				5	0	0
,, Staff Annuities (Annual Premiums)				100	0	0
,, Purchase of £161 0*s.* 6*d.* 2½ per cent. Consolidated Stock (Compounders' Fees)				150	0	0
,, Transfer to Pension Fund (Income Tax recovered)				6	4	0
,, ,, to Library Account				100	0	0
,, Return of Books and Collections from safe storage				34	18	3
,, Balance at 30 April 1946 :—						
Current Account at Bank	479	6	11			
Deposit Account Post Office Savings Bank	2041	18	7			
Cash in hand	17	19	2			
† Including £46 Composition Fees awaiting investment.				†2539	4	8
				£4886	17	2

Account

PAYMENTS	£	s.	d.	£	s.	d.
By Periodicals				106	2	1
,, Binding				68	5	0
,, Books				15	15	5
,, Balance at 30 April 1946. Current Account	20	14	1			
Deposit Account	70	0	0			
,, Deposit Account Post Office Savings Bank	100	0	0			
				190	14	1
				£380	16	7

Account

PAYMENTS	£	s.	d.
By Balance at 30 April 1946	50	0	11
	£50	0	11

Separate Account

RECEIPTS

	£	s.	d.	£	s.	d.
To Balance at 1 May 1945 :—						
Westwood Fund	60	6	5			
Trail Award Fund	36	9	2			
Crisp Award Fund	52	10	8			
Hooker Lecture Fund	155	10	8			
Goodenough Fund	7	7	4			
Minchin Fellowship Fund	7	15	5			
Carnegie Corporation Grant	752	17	1			
Reserve Fund	1450	0	0			
				2522	16	9
,, Transfer from General Fund Account Pension Fund				6	4	0
,, Interest on Investments (including Income Tax recovered) :—						
Westwood Fund	10	17	4			
Trail Award Fund	3	10	0			
Crisp Award Fund	10	4	8			
Hooker Lecture Fund	21	18	0			
Goodenough Fund	8	12	8			
Minchin Fellowship Fund	3	0	0			
Staff Pension Fund	7	3	5			
				65	6	1
				£2594	6	10

PAYMENTS

	£	s.	d.	£	s.	d.
By Carnegie Grant :—						
Printing the Catalogue of the Linnaean Herbarium	296	13	6			
Plates for Catalogue	37	0	0			
				333	13	6
,, Hooker Fund :—						
Printing Hooker Lecture				81	6	6
,, Staff Pension Fund :—						
Purchase of £9 12*s.* 2*d.* 3 per cent. Savings Bonds 1955/65				9	16	8
,, Balance at 30 April 1946 :—						
Westwood Fund	71	3	9			
Trail Award Fund	39	19	2			
Crisp Award Fund	62	15	4			
Hooker Lecture Fund	96	2	2			
Goodenough Fund	16	0	0			
Minchin Fellowship Fund	10	15	5			
Carnegie Corporation Grant	419	3	7			
Reserve Fund	1450	0	0			
Staff Pension Fund (for investment)	3	10	9			
				*2169	10	2
				£2594	6	10

* Including £2100 in Post Office Savings Bank.

Investments on 30 April 1946

General Account

£	s.	d.			Market Value 30 *April* 1946. £	s.	d.
1000	0	0	3½ per cent. London County Consolidated Stock 1958–68	@109	1090	0	0
1000	0	0	Great Western Railway 4 per cent. Debenture Stock	@112	1120	0	0
312	0	0	London Midland & Scottish Railway 4 per cent. Preference Stock	@ 80	249	12	0
338	6	8	3½ per cent. War Stock	@106⅜	359	18	0
1000	0	0	3 per cent. Defence Bonds	@100	1000	0	0
2199	18	6	4 per cent. Australian Stock 1961–64	@115	2529	18	3
200	0	0	3 per cent. War Stock 1955–59	@106½	213	0	0
1139	13	0	3 per cent. Savings Bonds 1955–65	@106	1208	0	7
2075	8	5	2½ per cent. Consolidated Stock	@ 97½	2023	10	8
176	19	3	3 per cent. Savings Bonds 1960–70	@106½	188	9	3
					£9982	8	9

Library Account

£	s.	d.			£	s.	d.
450	0	0	Forth Bridge Railway 4 per cent. Stock (Bentham Bequest)	@102	459	0	0
103	12	5	Surrey County 3 per cent. Stock 1961–66 (Wakehurst Bequest)	@104½	108	5	8
191	12	7	4 per cent. Australian Stock 1961–64 (Walker & Morey Bequests)	@115	220	7	6
107	2	1	2½ per cent. Consolidated Stock (Stebbing Bequest)	@ 97½	104	8	6
530	0	0	3 per cent. Savings Bonds 1960–70 (Tagart Bequest)	@106½	564	9	0
					£1456	10	8

Separate Account

	£	s.	d.			£	s.	d.
£1063 10 7	232	5	0	Metropolitan Water Board 3 per cent. "B" Stock (Westwood Bequest)	@102	236	17	11
	667	14	2	Ditto ditto (Hooker Lecture Fund)	@102	681	1	3
	163	11	5	Ditto ditto (Goodenough Fund)	@102	166	16	10
	100	0	0	New South Wales 3½ per cent. Stock, 1930–50 (Trail Award Fund)	@103	103	0	0
	409	11	1	2½ per cent. Consolidated Stock (Crisp Award Fund)	@ 97½	399	6	4
£380 10 6	156	7	2	" " " (Westwood Fund)	@ 97½	152	9	0
	74	14	6	" " " (Hooker Lecture Fund)	@ 97½	72	17	2
	149	8	10	" " " (Goodenough Fund)	@ 97½	145	14	1
	248	1	9	3 per cent. Savings Bonds 1955–65 (Staff Pension Fund)	@106	262	19	6
	100	0	0	" " " 1960–70 (Minchin Fund)	@106½	106	10	0
				F. C. STERN, *Treasurer.*		£2327	12	1

We have (in conjunction with the Professional Auditors, who certify as to all details) audited the Accounts of the Society for the year ended 30 April 1946 and found them correct. We have verified the Investments and Bank Balances.

Dated this 15 May 1946.
W. B. KEEN & Co., *Chartered Accountants,*
224 Regent Street, London, W. 1.

A. H. G. ALSTON,
B. BARNES,
I. HENRY BURKILL,
A. A. PEARSON,
D. J. SCOURFIELD.
Audit Committee.

The Librarian and Assistant Secretary presented his Report.

LIBRARIAN & ASSISTANT SECRETARY'S REPORT.

List of the Society.—Since the last Anniversary Meeting the Society has lost 33 members. The detailed statement is as follows,—

17 *Fellows by death,*—Dr. Lev Cernosvitov, Hayward Radcliffe Darlington, Major Stanley Smyth Flower, O.B.E., Rev. Canon Francis William Galpin. Prof. John Stanley Gardiner, Dr. John Henry Garrett, Dr. Surendra Lal Ghose, Arthur Edward Goodman, Prof. Edwin Stephen Goodrich, Sir Cuthbert Cartwright Grundy, Kt., Henry Haselfoot Haines, C.I.E., Walter Eric James, Dr. George Valentine Chapman Last, Col. J. Hamilton Leigh, Miss Catherine Alice Raisin, Miss Edith Rebecca Saunders, Dr. James Watt, W.S.

9 *Foreign Members by death,*—Prof. Thomas Barbour, Prof. Gottlieb Haberlandt, Prof. Seiitiro Ikeno, Prof. Vladimir L. Komarov, Prof. Thomas Hunt Morgan, Prof. Adolf Pascher, Prof. Paul Pelseneer, Prof. Gustav Senn, Prof. Karl Tubeuf.

3 *Fellows by withdrawal,*—Ernest Melville Cutting, Dr. John McEwen Dalziel, Rev. Alexander Frank Fountain.

4 *Fellows by removal from the List,*—Herbert Gordon Garratt, Tokutaro Ito, Miss Jessie Leese, Dr. Embrik Strand.

The number of Fellows on the List is 613, with 40 elected today and not yet qualified. 12 Foreign Members and 1 Associate *honoris causa* have been elected.

Library.—Between 1 May, 1945 and 30 April, 1946, 14 books have been purchased, and 20 books, 173 parts of periodical publications and 151 reprints have been presented.

The number of volumes borrowed by Fellows and Associates was 802 and by The National Central Library 213. 437 signatures were recorded in the Library Visitors' book. During the same period the number of volumes bound was 148.

Linnaean Collections.—After being in safe storage since April, 1939, the Linnaean Collections have now been brought back to the Society's Rooms from the Zoological Museum, Tring, where they had remained since 12 July, 1941, when they were removed from Woburn Abbey. During the coming months the Collections will be carefully examined.

During the past year the printing of my 'Catalogue of the Linnaean Herbarium' has been completed; and in due course copies will be sent to the principal herbaria.

THE PRESIDENT'S REVIEW.

I must first of all express my sincere regret that it was necessary for me to be absent from so many Meetings during the later part of the Session. The Council have shown great sympathy and forbearance, and arranged for the Treasurer, as senior Vice-President of the Society, to take my place during the remainder of the Session. I am greatly indebted to Colonel Stern for so kindly and willingly giving up his time for these additional duties. He has not only presided at the General Meetings but at all the other and more numerous business meetings of the Society.

The Presidential Addresses of the Linnean Society have usually consisted of two parts, the first being concerned with the Society's welfare and the second being of the nature of a scientific discourse. Fellows will remember, however, that the Council passed a resolution early in 1945 that, as is customary in most societies, the President should not be expected to deliver more than one Scientific Address. If a President takes advantage of this ruling his Scientific

Address would normally be given at the conclusion of his term of office. My Address in 1944 on the Megaphytic Habit in Plants covers all that is required of me, but if time permits I propose, after the conclusion of the first part of the Address, to offer a few remarks concerning the distribution of the Tree Senecios.

The Assistant Secretary has informed you that we have lost 24 Fellows since the last Anniversary Meeting, and these included 17 losses by death. Among these are several distinguished names, notably Professor E. S. Goodrich, Zoological Secretary from 1915 to 1923 and Linnean Medallist in 1932, Professor J. Stanley Gardiner, Linnean Medallist in 1936, and Sir Cuthbert Cartwright Grundy in his 100th year. He was the ' Father of the Society ', being elected in 1872.

We have also lost nine Foreign Members, including Professor Gustav Senn of Basle, who was not only a systematist, physiologist and algologist but also an authority on ancient Greek botany ; and Professor Vladimir L. Komarov, the distinguished Russian botanist, author of the Flora of the U.S.S.R., and President of the Soviet Academy of Sciences, to whom we had the pleasure a year ago of sending a telegram of congratulation on the occasion of the 220th Anniversary of the Academy.

You will have noted that the number of Fellows elected this afternoon was 40, which gives us a net gain of 18 Fellows. This is a matter for congratulation as it is the largest increase in the number of Fellows for any one year since 1922.

From the Treasurer's Report you will have gathered that, although we shall be faced with heavy expenditures in the future, through his careful and able guidance, the Society's finances are in a satisfactory state.

Owing to the excessive calls on the time of scientists and to the difficulty of arranging meetings it was considered advisable to reduce by one the number of General Meetings held during the Session. The attendance at Meetings has been good. The most important was the Discussion on Oceanography held on 21 March, to which we welcomed the presence of Dr. Johan Hjort of Norway, President of the International Council for the Exploration of the Sea, Dr. H. Blegvad of Denmark, the General Secretary of the International Council and Dr. K. A Andersson of Sweden. Two of these scientists travelled by air in order to take part in the Meeting. The report of the Discussion was, by order of Council, sent at once to the printers and has already been published and circulated as a pamphlet.

In this connection I may mention that the Council has lately been considering the format of the ' Proceedings '. It has been decided to adopt a size which is nearly the same as that of the Journal ; and by choosing a fount of type suitable in relation to the width of the lines and the height of the type-space, the ' Proceedings ' should be greatly improved.

During the present Session the Catalogue of the Linnaean Herbarium, by the Assistant Secretary, has been published in an edition of 250 copies ; the limited edition being due to paper restrictions. A Sub-Committee has been appointed to allocate these copies to the principal herbaria, and to consider whether further copies can be produced in facsimile, and offered for sale. Fellows will wish to express their thanks to Mr. Savage for this labour of love and to offer him their congratulations on its completion.

Fellows will be glad to learn that a large number of the books sent away for safe storage have now been returned to the Library,—about 2,000 volumes were brought back from The Zoological Museum, Tring, in May, 1945 ; and a similar number stored in one of the Herbarium air-raid shelters at the Royal Botanic Gardens, Kew, were sent back in September, 1945. About 3,000 volumes have still to be returned from the Bodleian Library, as well as the Society's Archives and Miscellaneous Manuscripts from Simpson House, near Bletchley, where they have been kindly housed and tended by Mr. Warren R. Dawson, F.S.A. They will also have heard with satisfaction that the Linnaean Collections are now safely back in our Rooms, and should soon be available for consultation ; and they will I know have noted with pleasure from the Assistant Secretary's Report that every specimen will be scrutinized by him personally.

A beginning has been made with the repairs rendered necessary as a result of War damage. In this matter the Society is in the hands of the Ministry of Works, since, as I explained last year, owing largely to the remarkable foresight of the Prince Consort, the Government are responsible for the upkeep of the fabric of Burlington House. I am glad to be able to report that the repairs to the inner glass roof of the Library are at length practically completed, and the Library should be water-tight. We had hoped that these would have been finished before last autumn. The protracted delay and bad condition of the roof was one of the reasons which led the Council to abandon the evening Reception which had been planned for October.

Another and very satisfactory announcement is the return of our Clerk, Mr. Theodore O'Grady. We welcome him back after six and a quarter years of service in the Army. He comes at a time when his help is greatly needed, not only to relieve the Assistant Secretary of duties he willingly took over during the war, but in the increased clerical work which has fallen on the Society.

A matter which always interests Fellows is the Society's collection of portraits. They will have noticed that the portraits hung in this Room of McLeay, Bennett, Yarrell and Percy Sladen have been restored. In this work we have had the benefit of the advice and skill of Mr. James Bateman, R.A. The restoration of several other portraits is under consideration. The Council have furthermore appointed a Sub-Committee to report on all the pictures and portraits in the Library and other rooms, especially with regard to re-arrangement. It has been obvious for some time that the large number of the portraits acquired during the course of years have been hung in somewhat a haphazard manner, and that the arrangement could be greatly improved.

We come lastly to the matter of co-operation with other societies. Once again we have been glad to place our Rooms at the disposal of other biological societies. During the past Session they have been used for meetings of the following fourteen,—

British Mycological Society, S.E. Union of Scientific Societies, British Ecological Society, Genetical Society, Botanical Society and Exchange Club, British Association Committees, Malacological Society, Society for Experimental Biology, Association of Applied Biologists, Ray Society, Association for the Study of Systematics in relation to General Biology, Challenger Society, Scottish Seaweed Research Association and Biological Council.

During the Session the officers of the Society have been in close touch with the officers of the Association for the Study of Systematics in relation to General Biology, with a view to renewed and closer co-operation. A draft resolution to this effect was drawn up. While the considerations were in progress, however, new negotiations were opened up with representatives of the Biological Council; and pending arrangements with the Biological Council it was felt desirable to postpone any new Agreement with the Association for the Study of Systematics. The old Agreement with the Association was therefore renewed for the period of one further year.

A meeting of the Biological Council, which included representatives of all the most important biological societies in this country, was held in the Society's Rooms on 21 November, 1945. As a result of this meeting a Sub-Committee of the Linnean Society's Council was appointed to look into and report on the questions discussed and proposals put forward. Their report, which though in general terms, was entirely sympathetic, was accepted by the Council, and the following resolution was passed and sent to one of the Secretaries of the Biological Council,—

> 'That the Linnean Society should take an active interest in the aims of the Biological Council and that the Linnean Society, in order to help, would be prepared to make the following offer if the Biological Council considered such organisation would be useful'.

The offer concerned the use of the Society's Rooms, the reference use of the Library, attendance at Meetings, a Secretariat and other matters. As Fellows will be aware, the matter of co-operation between Scientific Societies is at present much discussed, and quite recently yet another important form of organisation has been proposed. It is obvious, therefore, that much thought and discussion are needed before any decision can be arrived at.

In conclusion, before turning to the distribution of the Senecios and then vacating this chair, I wish to refer to the matter of general taxonomy.

In any study of the distribution of plants or animals one is concerned with *species*, and when you are dealing with species or other similar units you are faced with taxonomy and have to use taxonomic literature. If the taxonomy is wrong, or seriously imperfect, an account of the Senecios such as I have written cannot be attempted. If it were attempted the results would be misleading.

It was the impossibility of reconciling the records of species of Dendrosenecios on Kilimanjaro and on other mountains which led me to take up the taxonomic study of the group in 1930. Many records existed in systematic literature; and ecologists and others used these records for their field work and in their published papers. When I came to examine them I was confronted by a state of affairs only too familiar to all experienced taxonomists. Except where new species were concerned or cited, no record whether in floristic or ecological literature could be accepted at its face value. This casts no reflection on the botanists of the past. It illustrates the slow growth of a difficult branch of botanical science and manifests the need for further and more intensive taxonomic research and for closer co-operation both with field workers and between systematic institutions at home and abroad.

I do not profess that the classification I have prepared is perfect or final, since much more field work and probably experimental work such as breeding is necessary, but with the aid of as much co-operation as possible with field workers and by the examination of material in many herbaria, it is believed to be reasonably correct. (Up to 1939 an attempt was made to examine personally every dried specimen extant, namely those preserved in all the great herbaria of Europe, America and Africa.)

This brings me to my next point. Our Society is the one Society which, from its inception to this day, has cared for general taxonomy, and at the present time, when the subject tends to be overshadowed by other branches of biology, the Linnean Society has never shrunk from bearing the very heavy expense of publication of systematic papers even to the serious depletion of its funds. Systematic papers are not usually suitable for discussion or for reading at Meetings but are prepared for use and for reference. They have a permanent value not often attained by other papers. The Linnean Society aims at being broad in its interests, and one of its principal functions is the publication of such papers. Much of this is for the benefit of posterity. Taxonomic research and its publication is, in fact, in large measure, essentially a service.

Lastly, I would add, that there is no doubt that the standard of taxonomy needs to be raised aloft. Looking back on a period of 20 years, during which I had the privilege of being in charge of a great systematic institution, I became acutely conscious of the need of additional recruits to this branch of biology. Unless such recruits be forthcoming, and in considerable numbers, the immense floras and faunas of the world can never be properly understood. Only those who have worked with such world floras and faunas have any conception of their magnitude and their riches in genera and species. Having been trained under Sir John Bretland Farmer, the greatest cytologist of his day, and having been associated with Prof. F. W. Oliver in his ecological work at Blakeney, I recall the intense fascination of these subjects and do not underrate their value. Such branches of biology naturally make an appeal to the present-day student also, not only on account of their intrinsic interest but because of their suitability for short-term research. But their very interest and fascination is apt to lead to the less exciting, more exacting, but all-important work of taxonomy being passed by. It may even fall into disrepute among those who do not realise its value, or who think of it only in terms of nineteenth century systematics. Having myself worked a little in the immense fields of taxonomic botany (both Cryptogamic and Phanerogamic) I would appeal to the young biologist to consider seriously the claims of this branch of their science. There can be no question of the need for a greater number of professional taxonomists. All parts of the world are crying out for up-to-date Floras. The Flora or Handbook which the ecologist or economic botanist demands when he takes up a colonial appointment can only be prepared after years of patient labour in a systematic institution, whilst our fortunate colleagues who carry out researches on such subjects as physiology and genetics require correctly named material or they may find their results at variance with those of other workers.

From what has been said it will be seen that this plea on behalf of Taxonomy has not been made on account of personal preference but from a sense of responsibility and a desire to serve the interests of biologists as a whole.

The President then made some observations on the Distribution of the Dendrosenecios, which will be included in his Monograph on the group to be published later.

The PRESIDENT then delivered his Address on the 'Tree Senecios'.

On its conclusion, Dr. J. RAMSBOTTOM, O.B.E., moved 'That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows '. The motion was seconded by Dr. M. A. BRETT, and being put to the meeting was carried with acclamation.

The PRESIDENT then declared the Session of 1945–46 ended ; and invited the newly-elected President, Professor G. R. DE BEER, F.R.S., to take the Chair. Professor de Beer then addressed the Meeting, after which the proceedings terminated.

OBITUARIES.

Lev Černosvitov was born at Poltava in Ukraine in July 1902. From his childhood he had a passion for learning, and for zoology in particular, and his life was one long struggle to do scientific work. And at last, when the ambition of his life was about to be realized, he died.

He was a schoolboy of 14 when the Revolution came in 1917, living with his family in Petersburg. But life in that city became too difficult, and driven by hunger Černosvitov's mother went with her children to Chernogov in the fertile south where the food situation was better and where her father had a house. There they remained for two years but in trying and difficult times. Food was scarce and they lived in constant fear of arrest. Often to evade the political police they had to hide in the villages near the town. At the age of 15 Lev Černosvitov was arrested and released only by chance. It was too risky for him to remain where he was and his mother sent him further south.

In Kiev he joined the White army and fought with them—joining the horse artillery. During the retreat to the shores of the Black Sea he was taken ill with typhus. Yet in spite of his illness he managed to keep up with his regiment, riding on horseback. Finally he was evacuated with what remained of the army to Constantinople.

He was then 17 years of age, in a foreign country, and without either friends or money. To earn a living he undertook odd jobs such as loading ships delivering milk and working in cafés ; for a time he was a batman to some English officers. Often without money to pay for a lodging he slept in the streets. The road to science that he had sought from his childhood seemed closed to him for ever. He told me that at that time he often thought of committing suicide.

In 1921 he was adopted by a Czech charity organization and with some other Russian boys taken to Czechoslovakia. He received from them a small grant, enough to continue with his education and to keep him alive. In 8 months he had not only mastered the language of his new country but had taken his matriculation. In 1923 he entered the University of Prague, his small grant having been extended. He lived outside the City in a village where living was cheaper.

At the University he was able to satisfy his passion for zoology and chose Oligochaeta as his subject. ' Worms ' are not a spectacular branch of zoology but for him they were a fascinating field of exploration, a group much neglected but presenting a rich material upon which he could base general theories. It is interesting to know that the main lines of his study of the Oligochaeta were definitely formed in his student days and that he followed them throughout his life. One was the systematic arrangement of the group, based on a detailed study of their anatomy and their geographical distribution ; the other was the physiological side of their sexual development, a problem which he studied in the animal kingdom generally.

In 1925 he described his first new species of worms (*Rhynchelmis vejdovskyi*) and during his student days started work on the sexual processes in the Oligochaetes (self-fertilization, Biol. Zentralbl., **61**, p. 47, 1927 ; resorption of the spermatozoids. Vestn. VI sjesdu Csl. priz., Praha, 1928 ; physiological regression of sexual organs, Bull. biol. France, Belgique, **64**, 1930). During his holidays he travelled, mainly on foot, in the Carpathians, in Serbia and Bulgaria, collecting Oligochaetes. It was characteristic of the man that wherever he travelled he took an interest in the country itself, in the people and their language. His capacity for picking up languages was amazing. He was fluent in Russian, Czech, Bulgarian, Serbian, English, French, and German, and had a smattering of many more languages.

The material that he collected on his travels he studied and described himself. His knowledge of the Oligochaeta in the south of Europe, and especially in the Balkans, was unique, but his knowledge of the group extended far beyond south-eastern Europe. He became one of the recognized authorities on ' worms ' and material was sent him from many Museums for determination and description.

But his work on the Oligochaeta brought him no money, and after obtaining his doctor's degree his student grant came to an end, and he had to look round for work. He was employed as an assistant to Prof. Novikov, in Prague, working on the comparative anatomy of invertebrates, but the pay was insufficient to live on and he had to supplement it by doing other work. For a time he was employed in a dental clinic ; he also undertook work as laboratory assistant in bacteriology, in microscopic technique and in experimental medicine. From 1931 to 1933 he was engaged by the Experimental Station of the Ministry of Agriculture in the Argentine to work on insect pests in connection with Yerba Maté and Oranges. From 1933 to 1939 he was employed by the British Imperial Institute of Entomology to investigate the economic control of the White Spruce Saw Fly. But he never neglected his Oligochaetes and all his spare time was spent in studying them.

In 1939, through a grant from the Society for the Protection of Science and Learning, he was invited to work on the Oligochaeta at the British Museum (Natural History). For the first time in his life he could devote his whole time to them. But it was for a few months only. The Second World War broke out and Černosvitov was called away to do other work. His wonderful knowledge of European languages was at once made use of and he was engaged by the B.B.C. in its monitoring department. For six years, he was thus employed, his duties being to listen to foreign broadcasts and summarize them in English. In his hours of leisure and during his rare holidays he continued to work on the Oligochaetes.

When the war was over he was promised a permanent post on the staff of the British Museum. Fortune at last seemed to smile upon him. Before him lay the chance to work on the problems that he had been considering all his life. A few weeks later he died. He was forty-three.

In spite of the brief time which Černosvitov could spend during his life on the study of the Oligochaeta, he published 73 papers dealing with them and left behind him a large Monograph on the British Oligochaetes almost ready for publication. He put on a sound basis the systematics of the group generally and wrote monographs upon them dealing with several large geographical regions. His work on the regression of sexual organs in the Turbellaria and the Oligochaeta and the absorption of spermatozoa in the animal kingdom are of great general interest.

Looking back now on his life one cannot help admiring his great determination and the courage with which he followed his aims and faced continual setbacks. Twice he had to change his country and his nationality. At an early age he had to undergo ordeals that would have broken up many men. Several times in his life his work was interrupted for years. Černosvitov was the true scientist. For him science was not a career taken up merely to earn a living; it was the aim of his life. For it he sacrificed everything.

May I end this brief note on an outstanding man by an expression of deep sympathy for his wife and mother. V. TCHERNAVIN.

THE death was announced on 24 June 1946, at the age of seventy-three, of Professor **Bertram Henry Bentley,** Emeritus Professor of Botany in the University of Sheffield. A scholar of Keble College, Oxford, Professor Bentley secured a first class in Natural Sciences in 1896 and was appointed to the staff of Firth College, Sheffield, subsequently becoming Lecturer in Botany in the Department of Biology in the new University. As the number of students increased under his care he was made head of the newly-formed Department of Botany, and in 1931 the University honoured him with a professorship.

In the work of building up the department, Professor Bentley's time was devoted largely to teaching and administration. Much influenced by A. H. Church, for whom he had the greatest respect, and by the distinguished contributions of Bower and others to the study of phylogenetic problems, he took pains to see that his students were well grounded in this aspect of botany. It was the morphological rather than the physiological approach which appealed to him.

Professor Bentley was a real lover of plants both in the field, and in the garden and allotment which he so much enjoyed. He taught, whenever possible, from fresh material and was always anxious that his students should not accept without question the text-book accounts of familiar plants. He showed great skill in nature photography and illustrated his lectures with many slides of his own making. Before his retirement a good deal of his time was spent in the devoted care of his wife who, following overstrain in the last war, was an invalid. His own latter years in Cheltenham were clouded by her death and by the gradual loss of his eyesight. E. M. LIND.

Mr. **Charles Taborn** was born in Leicestershire in 1884. He was a member of the teaching profession and up to the end of the 1914–1918 war was headmaster of Hickling School. He was a keen and able horticulturist and gardener, and his services were enlisted by local authorities during this period to advise and assist allotment-holders and others in the production of home-grown food. His work in this field proved outstandingly successful, and he relinquished his teaching post on his appointment as Horticultural Adviser to the Nottinghamshire County Council.

In this capacity his enthusiasm and energy gave him a unique position among both the commercial and amateur horticulturists in the County, and much of his time was spent in lecturing, judging at shows and the like.

When the second World War broke out his help was in constant demand and he did yeoman service.

He was greatly interested in the Nottingham General Hospital and was a member of the Monthly Board.

He was instrumental in securing the collaboration of numerous gardeners in supplying vegetables and fruit to the Hospital.

He died suddenly at his home in West Bridgford and is survived by his widow and one son. H. S. HOLDEN.

The Rev. **Alfred Thornley,** M.A., who died at his residence at St. Ives, Cornwall, on Sunday, 5 January 1947, in his ninety-second year, was one of our senior fellows.

He was born at Preston, Lancashire, and was educated at Manchester Grammar School and Merton College, Oxford.

He was ordained in 1879 and when I first knew him was Vicar of St. Jude's, Nottingham. Soon afterwards he accepted the country living of South Leverton, where his outstanding ability as a field naturalist found a wider scope.

He was a pioneer in the teaching of the natural sciences and gave lectures in botany, zoology and geology over a wide area of the East Midlands.

He was a born teacher and his lectures soon attracted the attention of the Board of Education and the local Education Authorities, this leading to his release from parochial duties so that he could supervise the teaching of Nature Study in the schools of Nottinghamshire and Leicestershire.

His zest and ability as a systematist had already led to a close and enduring friendship with Professor J. W. Carr, who was head of the Department of Biology at University College, Nottingham, and they collaborated in undertaking a thorough survey of the invertebrate fauna of Nottinghamshire, adding numerous records to the County list.

He was appointed chaplain to the Royal Agricultural College, Cirencester in 1922, and served there in that capacity and as Professor of Entomology until 1925, when he retired to St. Ives. Here he busied himself collecting and identifying the insects of his adopted county, and it is gratifying to know that the valuable and extensive collection he then made has found a home at the British Museum of Natural History.

Cultured, modest and scholarly, a delightful friend and companion and a gifted and inspiring teacher, he has left a legacy of solid achievement and of happy memories to those of us who were privileged to know him.

H. S. HOLDEN.

Albert Bruce Jackson was born at Newbury, Berks, on 14 February 1876 and died at his home, 3 The Avenue, Kew Gardens, Surrey, on 14 January 1947. He was educated at Woodspeen House School, Newbury, and after leaving school started as a junior reporter on the *Newbury Express* and later carried on journalism in Leicester. He had been interested in botany from a youth and hankered after a botanical career. His first professional appointment in botanical work was in February 1907 when he obtained a temporary post in the Herbarium of the Royal Botanic Gardens, Kew. He occupied this post for only a short time, and then he became assistant to H. J. Elwes and A. Henry in the preparation, centred at Kew, of "The Trees of Great Britain and Ireland". It was this connection that resulted in his becoming a specialist in trees. In 1910, on the recommendation of the Director of Kew, he was appointed a technical assistant at the Imperial Institute and served on the staff there till 1932. After his retirement from the Imperial Institute he was employed till the time of his death in the Department of Botany, British Museum (Natural History).

Bruce Jackson was keenly interested in the British flora, especially in the flowering plants and mosses for both of which he had made excellent private herbaria. He published (sometimes in collaboration with other botanists) a number of papers, especially in the *Journal of Botany* and the *Kew Bulletin*, on *Thymus*, *Barbarea*, *Rubus*, and other genera. His main work in botany, however, was concerned with trees and shrubs in cultivation in gardens and parks in this country. In 1910 he issued a 'Catalogue of Hardy Trees and Shrubs growing in the Grounds of Syon House'. He was placed in directive charge of the woody plants at Woburn and published accounts, some with valuable notes and illustrations, of the collections at Yattendon Court (1911), Albury Park (1913), Westonbirt (1927), and Borde Hill (1935). He was joint author with H. Clinton Baker of 'Illustrations of New Conifers' (1935). In

1923 there appeared the first edition of Dallimore and Jackson's ' A Handbook of Coniferae '. A second edition was published in 1931 and another was in course of preparation when Jackson died. In 1946 he published a small book, under the title ' The Identification of Conifers ', which consisted essentially of keys and illustrations from the larger ' Handbook '.

Bruce Jackson was of a quiet, studious temperament and of a most kindly nature. He was always willing to place his knowledge and experience at the service of anyone seeking his aid and his correspondence was a large one. He will be greatly missed by his friends, and it appears doubtful if the niche he made for himself can ever be adequately filled. He leaves a widow and three sons.

Bruce Jackson was elected an Associate of the Linnean Society in 1917 and was awarded the Veitch Memorial Medal of the Royal Horticultural Society in 1925.

W. B. Turrill.

Robert Newstead, F.R.S., an honorary associate of the Linnean Society since 1902, was born on 11 September 1859, at Swanton Abbot, Norfolk, and died at his home in Chester on 21 February 1947. He left school at the age of nine and a half, but even during this brief schooling is said to have played truant as often as possible in order to follow his interest in natural history. His early love of birds and flowers was partly inspired by his father, but he was obviously a born naturalist and keen observer. Before ten years of age he was apprenticed to the village post and telegraph office, which included also a printer's and stationer's works. He studied telegraphy and became a telegraphist at Aylsham. He next took up gardening, and other outdoor jobs, but devoted his spare time to the study of zoology and taught himself the elements of taxonomy. He made collections of plants, animals and birds, and in 1883, at the age of twenty-four, was invited to exhibit some of his Norfolk collections at Chester. His specimens attracted the notice of the late Mr. Alfred Walker, an enthusiastic naturalist, who offered Newstead an appointment in his gardens and gave him facilities for developing his natural gifts. He became a member of the Chester Natural History Society and in 1886 was appointed first curator of the newly opened Grosvenor Museum. He held this post until 1905, and during this period established his reputation in various branches of natural history, especially agricultural zoology, and completed his well-known Monograph on the British Coccidae, published by the Ray Society in 1902, based largely on his own collections later presented to the British Museum (Natural History).

In 1905 Newstead was appointed lecturer in medical entomology and parasitology at the Liverpool School of Tropical Medicine, and at once turned his attention to insects of medical and veterinary significance. He took part in two School expeditions, one to Jamaica in 1908, to study the scab disease caused by ticks on cattle, the other to Malta, in 1910, to investigate the life-cycle and biology of that very elusive insect, *Phlebotomus papatasii*, responsible for the transmission of sand-fly fever. In 1911 he was elected to the newly-founded Dutton Chair of medical entomology, and the same year went out to Nyasaland to join the Royal Society's Sleeping Sickness Commission. Here he studied the habits of tsetse-flies, especially in their relation to the maintenance and spread of sleeping sickness.

Newstead was elected a Fellow of the Royal Society in 1912. He was an original Member of the Honorary Committee of Management of the Entomological Research Committee (Tropical Office), appointed in 1909 by the Secretary of State for the Colonies. He served for many years on the Committee of this body and of its successor, the Imperial Bureau (now Institute) of Entomology.

During the war of 1914–18 he worked for the War Office as an entomologist and did very important work in connection with the organization of anti-fly campaigns to improve the sanitation of camps in France and Flanders. Subsequently he directed the Liverpool centre of the Royal Society Grain (Pests) War Commission, 1916–20, appointed to check the damage caused to food stores by insects and mites. In 1924, in collaboration with A. M. Evans and W. P. Potts, he published a 'Guide to the Study of Tsetse-Flies'; and the same year retired from his professorship.

His retirement gave him the opportunity of developing a long-standing interest in archaeology dating from his first appointment as Curator of the Chester Museum. His main energies were devoted to Roman Chester, and for many years no excavations took place without his being there to note and record any discoveries. He was appointed 'Recorder of Antiquities' to the city, and largely through his efforts many parts of the old Roman fortress have been uncovered, including the great barracks block in the Deanery Field and sections of the great amphitheatre. Accounts of these results were published in the Chester Society's Journal and constitute an important addition to British archaeology. Outside Chester, he also explored Roman sites at Prestatyn, Flintshire, at Lancaster, and elsewhere. As an archaeologist, Newstead not only did his own digging, but was an expert photographer, draughtsman, restorer, and recorder, and never hesitated to use his own funds. His services to Chester were recognized in 1936 by his election as an honorary freeman of the City.

Throughout the whole of his long and active life Newstead retained his youthful zeal, and is an outstanding example of a man who, though almost entirely self-educated, made important contributions in entomology and archaeology, and helped to stimulate a wider interest in those subjects.

EDWARD HINDLE.

Robert Almer Harper, elected Foreign Member 3 May 1928, was born 21 January 1862, at Le Claire, Iowa, U.S.A. He died at his farm home near Bedford, Virginia, 12 May 1946. He was for forty years one of America's leaders in the plant sciences, and his contributions to the morphology and cytology of the lower types of plant life won him well deserved recognition abroad.

Soon after his birth his parents moved across the Mississippi River to the little pioneer village of Port Byron, Illinois, located in that rich prairie country. It could be said of him that he was the product of that great Middle West, having spent nearly fifty years of his life in Illinois, Nebraska and Wisconsin. His mother was a great lover of nature and had acquired a very good working knowledge of the species of plants and animals of that region. The village school principal, a family friend, was also well informed on the local plant life and geology. The Harper boys, however, had very little formal schooling in that young country where their father was for over thirty years a Congregational missionary. The sons were taught at home and in the fields, and so came to be greatly interested in the botany and geology of the country for miles around. With Gray's botany in the hands of Edward and Wood's botany in Robert's it was always a race to see which won in keying out the species they had found on their long collecting trips. If Robert had lived in an earlier generation he would have become a noted taxonomist, so strong were his first interests in that direction.

Harper's home environment was excellent, but he was even more blessed by having already at birth been endowed mentally and physically with a rich inheritance. He always created a favourable environment wherever he came to live. His grandfather, Edward, belonged to one of the Harper families living in South Carolina in 1800, when Edward married Charity Reed, a Connecticut school teacher. It was she who saw to it that their numerous children made the most of life as they had to live it as they moved from place to place on their trek westward. On his mother's side Robert's grandparents were of good old Holland-Dutch colonial stock. Harper's father and mother and also their three sons graduated from Oberlin College, Ohio. The two oldest sons, Edward and Robert, later took their Ph.D. degrees in Germany, and the third son in Chicago. In view of such a record one would naturally think that the Harpers were of the ' well to do ' families of their day. All four, father and the three sons, however, had to work their way through college, each in his own way. To say simply that Robert ' worked his way ' would be missing the most interesting and admirable trait in his make up. Members of this Society little realize that when they elected him they were honoring a man who had the strength of character to win out against obstacles such as would have discouraged many others in their early struggles for an education. Robert sawed wood, milked cows, wheeled lumber in a saw-mill, drove mule teams on railroad grading jobs and cared for home gardens around Oberlin. When his funds ran low he would take a leave of absence from college and teach in a ' district school,' breaking colts for his board. Since it was one of his rules of conduct to do well at whatever task he set his hand, he soon established an enviable reputation as a ' horse breaker ' ! His associates in later life knew him only as a great botanist, a person who always presented the appearance of a well-groomed gentleman and scholar of the highest rank, endowed by nature with a magnificent personality. Had they known of his early struggles they would have readily understood that incidental backaching tasks, undertaken in youth with a high purpose, never leave blighting effects on one having the right heredity.

Oberlin College stressed the classics, but Harper through his own efforts acquired, on the side, much knowledge in the sciences. He first became Professor of Greek and Latin at Gates College in Nebraska, 1886–88. He then went to Johns Hopkins to do graduate work for some months. He taught physics, chemistry, and botany in Lake Forest Academy, Illinois, moving over to the University as Professor of Botany and Geology in 1891–98. His contacts at Johns Hopkins and later at the Marine Laboratory, Woods Hole, Mass. influenced him to take leave in 1894 to go to Bonn, Germany, to work with Strasburger on the cytology of the fungi. While there he heard so much of the celebrated mycologist Brefeld, that he went to Muenster to work in that laboratory. David Fairchild writes me :—' I was overjoyed to meet Harper there and felt his charming personality as I think Brefeld did, for he had a smile that was irresistible and a way of looking at you that made you conscious of a presence, a great presence, an outstanding presence ! ' It soon became evident to both professor and student that their views on the phylogeny and sexuality of the fungi were irreconcilable. Their relations soon became so strained that Harper, accompanied by Fairchild, went back to Bonn where, with Osterhout and other Americans, there gathered a noted group of investigators working with a Professor who encouraged rather than objected to independent thought. Dr. Osterhout in a recent letter which we may quote says of Harper :—' He was dean of the students in Strasburger's Laboratory and we all looked up to him and went to him for advice. He was a never failing source of inspiration and help in personal and professional matters, and he made our stay there more productive than would otherwise have been possible.'

Harper often spent his summers at the Woods Hole Laboratories. One summer he worked on the Pediastrums making innumerable photographs and notes on their morphogenetic features. He always had time to take a young physiologist (W. J. Robbins), whom he greatly admired, on trips collecting mushrooms. Robbins tells me that he once cooked some specimens of *Polyporus sulphureus* with milk, butter and a salt dressing. ' Harper tasted my preparation,—" Well ", he said with a twinkle in his eye, " I believe that it is fully equal to a good grade of filter paper cooked the same way ". Harper's absorption in botanical problems of all kinds, his good humour, his tolerance for and interest in the beginner, his bigness in both mind and body left an impression I have never forgotten'. One of Harper's later students wrote of him as having a fine personal and professional life, and also a 'brilliant' philosophy.

Few botanist think of Harper as a plant pathologist yet few teachers were as well informed on host-parasite relations. One has only to list his graduate students to see how many theses on plant diseases were written under his guidance.

Harper himself never ceased to be grateful for the opportunity to work with Strasburger from whom he acquired great skill in cytological techniques. This enabled him to discover how ascospores are delimited by 'free-cell formation' and that spores in sporangia of *Pilobolus* and *Sporodinia* are formed by 'progressive cleavage'. These fundamental differences convinced him that the ascus could not have evolved from the sporangium. The fungi are polyphyletic rather than monophyletic as Brefeld held. Harper nevertheless had the greatest admiration for him and always dwelt in his lectures at great length on the beauty and accuracy of Brefeld's illustrations, with never a word of bitterness because of their earlier differences.

Returning to America in 1896 Harper continued his researches at Lake Forest until he was called to the University of Wisconsin as Professor of Botany in 1898. Many foreign botanists visiting America took that long trip to Madison in order to meet him in person. In 1911 he went to Columbia University as Torrey Professor of Botany and head of the department, a position he filled with great distinction until he retired in 1930. For several years he still continued his researches on morphogenesis, but he was always accessible to graduate students and colleagues.

Harper will always be remembered for his admirable work in support of his theory of a double fertilization in the ascomycetes. An embryo of an animal, and a seed of a plant have their origin in the union of two gametes. Therefore, he believed, an ascocorp primodium must be the seat of a nuclear fusion, the fusion in the ascus being merely a compensatory one. As time passed much further evidence was brought forward in England and America in support of this view. Genetic methods, however, may prove that in most ascomycetes as well as in all other organisms there is only a single nuclear fusion in a life cycle. A double fertilization must be the exception rather than the rule.

It was Harper's great skill as a teacher and ability to conduct seminars and to direct research that won him the love and esteem of all his students. His reputation among botanists will live on long after his controversy with Dangeard over the nature of sexuality in the ascomycetes has been forgotten. Any one of his graduate students and associates would have been glad of an opportunity to pay tribute to this celebrated botanist, this great teacher, wise counsellor and loyal friend, Robert Almer Harper. B. O. DODGE.

Professor **Edwin Stephen Goodrich,** M.A., D.Sc.(Oxon), LL.D.(Edinb.), F.R.S., was the younger son of the Rev. O. P. Goodrich, and was born at Weston-super-Mare on 21 June 1868. He was descended from the branch of the Goodrich family which had settled in Virginia in 1630, but of which his immediate forbears had returned to England in 1775. His early schooling was carried out partly in France and partly in England. At an early age he became interested in natural history. He died at Oxford on 6 January 1946.

In 1888 Goodrich, then twenty years of age, entered as an art student at University College, London, under Alphonse Legros; his intention being to become a painter. However, through Ray Lankester's influence he turned to zoological studies, although retaining all his life his interest in and practice of the art of painting. He became assistant to Ray Lankester when the latter was elected to the Linacre Chair of Zoology at Oxford; and entered Merton

College as a commoner in 1892. From then onward he became eminent as a sound zoologist, and when G. C. Bourne died in 1921 he succeeded him in the Linacre professorship.

His printed works included two extensive contributions to Ray Lankester's 'Treatise on Zoology', as well as three separate books—'The evolution of living organisms' (1912; ed. 2, 1920); 'Living organisms' (1924); and 'Studies on the structure and development of Vertebrates' (1930). His scientific achievements covered a wide field and have been dealt with very fully in Professor G. R. de Beer's notice in the Royal Society's Obituaries. Another lengthy notice of them, by Professor A. C. Hardy, will be found in the Quarterly Journal of Microscopical Science, vol. 87. part 4 (1946).

Professor Goodrich was Zoological Secretary of the Linnean Society from 1915 to 1923; a period when his calm, clear thinking was very helpful to the Society. In 1932 the Society awarded him the Linnean Medal; and he was awarded a Royal Medal by the Royal Society in 1936. Many other honours were bestowed upon him.

He was elected a Fellow of the Linnean Society in 1891, and served on the Council for four periods between 1911 and 1930; he was a Vice-President 1923–24 and 1929–30.

In 1913 he married Dr. Helen L. M. Pixell, who shared his enthusiasm for zoological research; and who survives him. S. SAVAGE.

William Herbert Mullens was born on 28 November 1866, at Hampton Wick, Middlesex, and was the eldest son of John Ashley Mullens. He was educated at Eton and Trinity College, Cambridge, where he matriculated in 1885, graduated B.A. in 1888, proceeded M.A. in 1892 and LL.M. that same year, and was called to the Bar, Inner Temple, in 1892. On his marriage in 1898 to Marguerite, daughter of A. de Wette, he received from his father as a gift the estate of Westfield Place, near Battle in Sussex, where he settled down to the ordinary pursuits of a country life.

It was here that he began the formation of the library of books on British Ornithology which formed the basis of his many contributions to ornithological literature. He was a studious admirer of Gilbert White of Selborne, and his lecture on the subject—delivered before the Hastings and St. Leonard's Natural History Society on 4 June 1907—was printed (with illustrations) in pamphlet form later in the year. His essays on 'Some early British Ornithologists and their Works' (published in *British Birds Magazine*: 1908/12) proclaimed his particular line of research. In 1911 he contributed a chronological Bibliography (1187–1900), as an appendix to Charles Stonham's 'Birds of the British Islands', which he compiled, almost entirely, from books in his own library. His pamphlet on 'Gilbert White of Selborne' was supplemented by his 'Guide to Selborne' and 'Synopsis of the Life of Gilbert White'; these were prepared for an expedition to Selborne which had been planned, in 1913, in connection with the twenty-first anniversary of the British Ornithologists' Club: the expedition, however, did not take place owing to the death of Dr. P. L. Sclater. In 1913 he edited and published John White's 'The Introduction to Fauna Calpensis', and in 1915 and 1917 he contributed two remarkable articles—on 'The Leverian Museum' and 'William Bullock's London Museum'—to *The Museums Journal.*

In all his works Mullens displayed not only indefatigable erudition, but also pains-taking accuracy and he will be best remembered for his 'Bibliography of British Ornithology' which he wrote, in conjunction with H. Kirke Swann. This was published in six parts (the first of which appeared on 20 June 1916, and the last on 29 June 1917), and was not a mere list of books, but a *catalogue* *raisonné* with biographies of the several authors. The ' Geographical Bibliography of British Ornithology from the earliest times to the end of 1918 ', by the same two authors and the Rev. F. C. R. Jourdain, was published in six parts (Part I, 7 Nov. 1919 : Part VI, 1 Sept. 1920). These two publications—the standard works on the subject—may, in course of time, be superseded, but they will always be the foundation on which future bibliographers will surely and gratefully build.

From time to time he presented birds which had been killed locally to the Hastings Museum : his contributions comprise about 180 mounted specimens, and include many rarities :—such as the Two-barred Crossbill, Tawny Pipit, Isabelline Wheatear, Slender-billed Curlew, Killdeer Plover and Sociable Plover. When leaving Westfield Place in 1922 for Kewhurst Manor, Bexhill, Mullens sold his library to Messrs. Sotheran as he felt that it had served its purpose in the issue of his two ' Bibliographies '. In this way his treasures were dispersed and other bibliophiles were able to add to their libraries. He was particularly anxious that I should acquire his copy of Turner's ' Avium praecipuarum : 1544 ' : since he had it from the library of my countryman Sir William Jardine, who had bought it at the sale of William Yarrell's books in November 1856.

Mullens had served in the Middlesex Imperial Yeomanry, in which he attained the rank of Major, and retired in 1907. On taking up residence at Kewhurst he interested himself in municipal affairs, and was elected to the Town Council of Bexhill in 1924, Mayor in 1927/8, and Deputy Mayor for the following two years, having been made an Alderman in 1928, in which capacity he served on the Council for several years. During his term of office he made several magnificient gifts to the Corporation, and in 1927, he published (privately) his ' Short History of Bexhill ', which stands as the only local history book of the town.

He was appointed a Justice of Peace in 1898, and later a Deputy Lieutenant of the County of Sussex, of which he was High Sheriff in 1916/17. He was a member of several learned Societies, having been elected a Fellow of the Zoological Society in 1889, the Linnean Society in 1909, and a member of the British Ornithologists' Union in 1893 : he was also a Fellow of the Royal Geographical Society and of the Royal Historical Society. From 1919 to 1931 he was Chairman of the Royal East Sussex Hospital, Hastings, and he was a prominent Freemason and a keen golfer.

Early in 1931 his many friends were shocked to hear that Mullens had been seized with paralysis of the spine. He never recovered, and died on 8 September 1946, leaving a widow, son and daughter : four days later he was buried, near his old home, at Westfield Parish Church.

It has been said—earlier in this obituary—that ' he settled down to the ordinary pursuits of a country life ', but these did not suffice : he took an active part in the conduct of local affairs and a kindly interest in the welfare of his poorer neighbours. As a bibliophile he was much more than a mere collector of books ; not only did he love them, but he also made use of them : moreover, he was tolerant and generous to other bibliophiles as I well know from personal and grateful experience. HUGH GLADSTONE.

BENEFACTIONS.

LIST *in accordance with Bye-Laws, Chap.* 17, *Sect.* 1. *of all Donations of the amount or value of Twenty pounds and upwards, receiving during the past five years.*

1942

Rockefeller Foundation : Donation in aid of publications, £200.
The Royal Society : Grant-in-aid of publications, £100.
India Office : Complete set of the Linnean Society of London's publications.

1943

Rockefeller Foundation : Donation in aid of publications, £100.
The Royal Society : Grant-in-aid of publications, £100.

1944

Rockefeller Foundation : Donation in aid of publications, £150.
The Royal Society : Grant-in-aid of publications, £50.
Mr. J. Insch : Donation to be used for the repair and binding of his collection of books on Tea, to be bequeathed to the Society, £100.
Gonville and Caius College : Donation in aid of the publication of Dr. V. J. Chapman's paper on the Vegetation of Jamaica, £50.
Lt.-Col. F. R. S. Balfour, C.V.O., J.P., D.L. : Transcription of the Journal of Archibald Menzies (1754–1842), bound in half leather ; 5 vols. quarto.

1945

The late Mr. H. N. Dixon ; Legacy for general purposes, £100.
The Royal Society : Grant-in-aid of publications, £650.
Rockefeller Foundation : Donation in aid of publications, £200.

1946

The Royal Society : Grant-in-aid of publications, £800.

ADDITIONS AND DONATIONS
TO THE
LIBRARY.
1945–46

Note.—Names of donors are given in square brackets. Separate copies of papers which are included in periodicals received by the Library are no longer catalogued.

Agar, W. E. A contribution to the theory of the living organism. Pp. 207. 8vo. *Melbourne*, 1943.

Ainsworth, G. C., & Bisby, G. R. A Dictionary of the Fungi. Pp. viii+431. 8vo. *Kew*, 1945. [Dr. G. C. Ainsworth.]

Arnal, Claude. Recherches morphologiques et physiologiques sur la fleur des Violacées. Pp. 262. 8vo. *Dijon*, 1945. [The Lady Isabel Browne.]

Arnold, G. The Sphecidae of Madagascar. Pp. 193. 8vo. *Cambridge*, 1944. [Nat. Mus. S. Rhodesia, Bulawayo.]

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Brooke, Winifred M. A. Sketches from Nature in the North of Ireland. Pp. 259. 4to. *Belfast*, 1935. [Author].

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Campbell, M. S. The Flora of Uig (Lewis): a botanical exploration. Pp. 63. 8vo. *Arbroath*, 1945. [Author.]

Caullery, Maurice. Biologie des jumeaux (polyembryonie et gémellité). Pp. 168. 8vo. *Paris*, 1945. [Auhor.]

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Drar, Mohammed. *See* **Täckholm, V. & G.**

Fairchild, David. Garden Islands of the Great East. Pp. xiv+239. 8vo. *New York*, 1944. [Dr. Malcolm Smith.]

Finnegan, Susan. *See* **British Museum (Natural History).**

Fitzsimons, V. F. The Lizards of South Africa. Pp. xv+528. 8vo. *Pretoria*, 1943. [The Transvaal Museum]

Francois, L. Semences et premières phases du développement des plantes commensales des végétaux cultivés. Pp. 184. 8vo. *Paris*, 1943.

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Friedberg, R. Les avoines cultivées en France. Pp. 172. 8vo. *Paris*, 1942.

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—— A Grammar of Botany. Pp. xx+242. 8vo. *London*, 1821 [Dr. O. R. Gurney.]

—— An introduction to physiological and systematical Botany. Ed. 6. Pp. xx+435. 8vo. *London*, 1827. [Dr. O. R. Gurney.]

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ERRATA

Page 1, line 19—*for* Cernosvitos *read* Černosvitov.
Page 70, line 15—*for* Hungry *read* Hungary.
Facing page 14, *after* Vol. 158. Pl. *add* 1.

[Part 2, pp. 77–149, *published 29 July 1947.*]